AUGUST 1956

Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN ENGINEERING

FIVE DOLLARS A YEAR

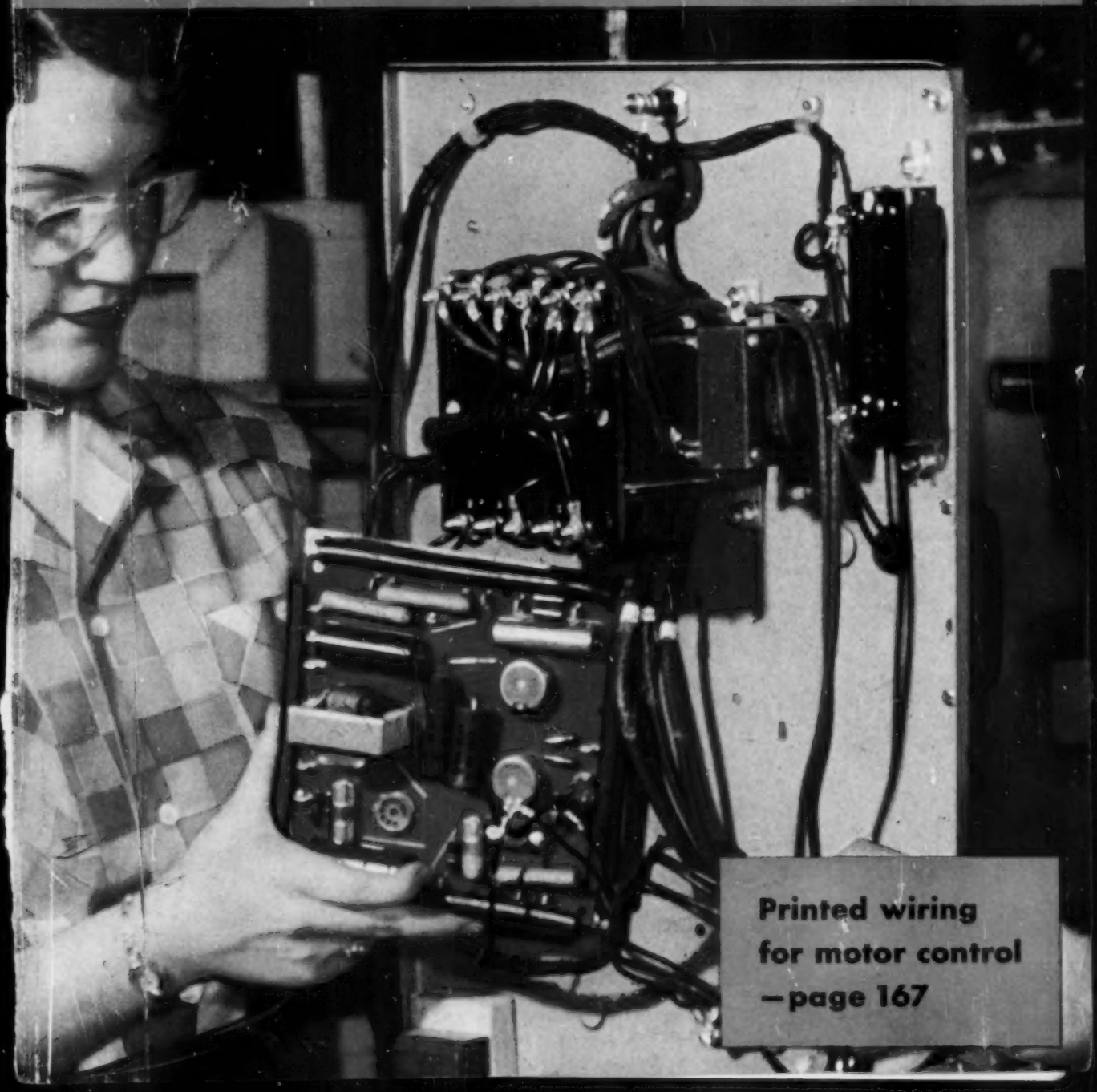
Power Spinning

as a forming process

Hydraulic Fluids

Quick-Release Fasteners

Gyroscopic Principles



Printed wiring for motor control
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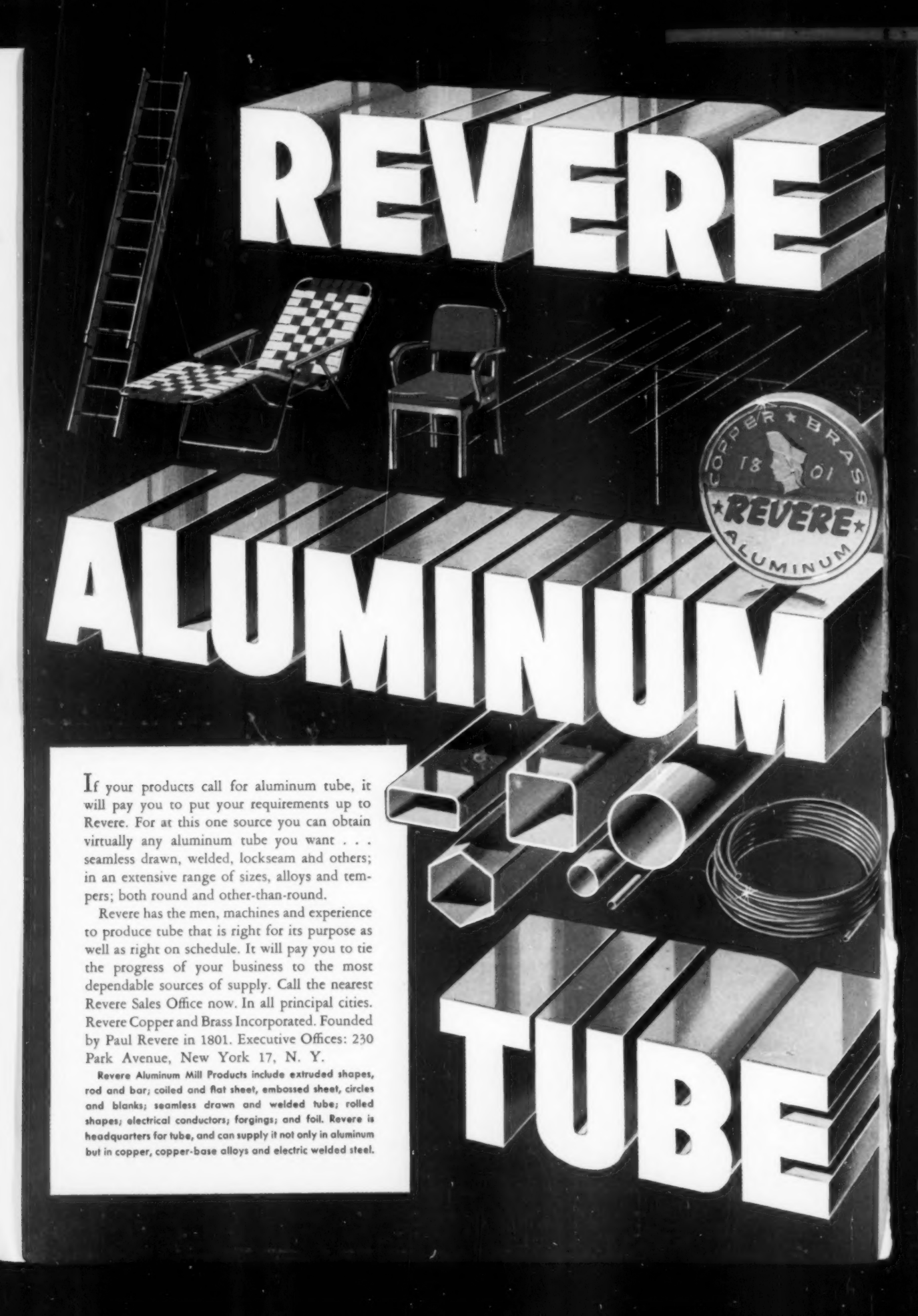

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MALLORY

These contacts, for a utility circuit breaker, look alike . . . but one costs only half as much as the other, as a result of consultation with Mallory Contact Specialists.

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Mallory Contact Engineering Offers Five Ways To Improve Economy

1. **The most effective contact material** from the extensive line developed by Mallory. More economical alloys often can satisfy *actual* service conditions.
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4. **The most economical backing member design** . . . in relation to contact and product design requirements.
5. **The most economical method of assembly** of contact and backing member.

By coordinating *all* these important elements of contact design, Mallory can help you put into effect a long-range plan for cutting contact cost and assuring peak performance.

CONTACTS can be *too good* for their intended service. Detailed study of a contact application, by Mallory engineers, often uncovers ways to design more closely to actual requirements . . . at substantial savings to the customer.

The contact pictured above is a typical example. Intended for use in a circuit breaker for utility distribution lines, it originally was designed with contacts made of heavy-duty silver ELKONITE®. At first glance, this exceptionally long-wearing, high conductivity metal appeared ideal to meet the customer's original specifications. But further investigation by Mallory contact engineers revealed that while contacts had to operate with absolute dependability, they did not have to function *frequently*.

On the basis of the actual frequency of service expected, Mallory engineers recommended a change to a copper ELKONITE . . . an alloy made of lower priced materials, and more economical to produce. Overall savings to this customer amounted to a 50% cut in contact costs. Moreover, there is no sacrifice in performance for the specific application.

Chances are that consultation by Mallory on your own contact applications can prove the source of interesting savings for you. Mallory engineers are well qualified by years of experience to analyze your requirements, to recommend materials from the extensive line of Mallory alloys, and to assist in overall design of contacts and assemblies. For a discussion, write or call Mallory today.

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THIS MONTH'S COVER

Printed wiring board, containing electronic sensing and control circuits, is being assembled into the panel of a General Electric thyratron adjustable-speed motor control made by the Apparatus Div., Winston-Salem. See "Printed Wiring for Industrial Control" page 167.

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Product Engineering
A McGRAW-HILL PUBLICATION

AUGUST, 1956 Vol. 27, No. 8

Published monthly, with an additional issue in Mid-October, by the McGraw-Hill Publishing Co., Inc., Executive, Editorial, Advertising and Subscription offices: **McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y.** Publication office, 99-129 North Broadway, Albany 1, N. Y. Donald C. McGraw, President; Paul Montgomery, Executive Vice President; Joseph A. Gerardi, Vice President and Treasurer; John J. Cooke, Secretary; Nelson Bond, Executive Vice-President, Publications Division; Ralph B. Smith, Vice President, Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; J. E. Blackburn, Jr., Vice President and Circulation Director.

FOR SUBSCRIPTIONS, write to: Subscription Service, 330 West 42nd Street, New York 36, N. Y. Subscriptions are solicited only from executives, engineers and consultants engaged in the design of machinery and other engineered products. **Orders must indicate company and position.** Allow one month for change in address.

Single copies 50c. United States and possessions, $5 for one year, $8 for two years, $10 for three years; Canada, $6 for one year, $9 for two years, $12 for three years; other Western Hemisphere and the Philippines, $15 for one year, $25 for two years, $30 for three years; all other countries, $25 for one year, $40 for two years, $50 for three years. Second class mail provisions authorized at Albany, N. Y. U. S. A.
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Developments

To Watch

PREDESIGNING ALLOYS. . . .

. . . according to projected needs rather than through trial and error, is a new research technique that has been termed a success by Westinghouse Electric Corp. The technique was applied to Nivco, a new alloy with high strength at 1200 F, five times that of the 12 percent chrome steel, and a damping effect almost as good as chrome steel at 900 F. Predicted uses are high temperature steam turbine blades and jet engines. Westinghouse stated that the mechanical behavior of a given alloy depends in part on its magnetic properties, and that the company now knows how to design certain mechanical requirements into certain alloys by control of their magnetic structure. This permits the prediction of the behavior of an alloy when certain metals are combined in different proportions without preparing and testing many potential combinations. The alloy is composed mainly of cobalt and nickel, but has smaller amounts of five additional unnamed elements.

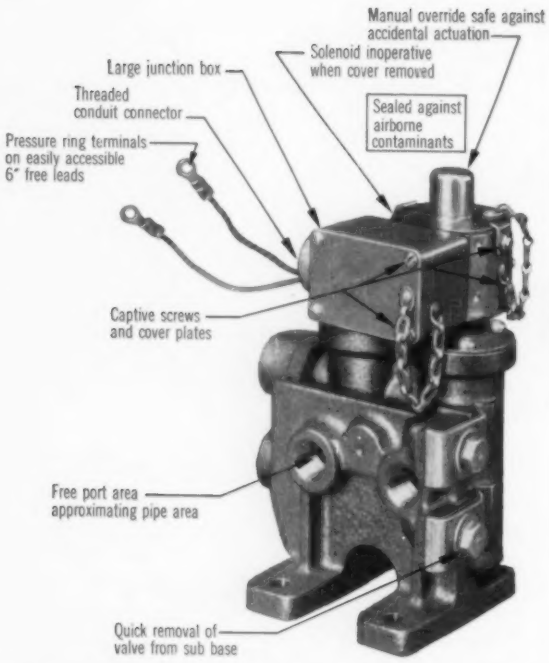
DIRECT READING OPTICAL MICROMETER. . . .

. . . developed at the Naval Ordnance Lab., White Oak, Silver Spring, Md., can be used to measure thicknesses and surface variations with an accuracy of 0.0001 in. As presently constructed, the micrometer resembles a toolmaker's microscope in that it has a mechanical horizontal stage and a vertical movement. However, in the new instrument the microscope is replaced by the new NOL device. An image of the surface point under view is reflected through two objective lenses, over reflecting mirrors; and through a common beam splitter. The two images are then superimposed tions with an accuracy of 0.0001 in. As presently constructed, the on a microscopic eyepiece that has a cross hair and the reading is taken. Reference points on the surface can be physical characteristics such as edges, dots, lines or scratches. An artifical mark can be created by a built-in optical system.

SMALLER OIL PRESSURE MEASURING SYSTEM. . . .

. . . for use principally in jet aircraft, does away with all exterior oil lines, and converts the oil pressure in the engine to electric signals which are transmitted to the instrument panel. The safety feature here, according to the Air Force, is the elimination of oil lines in which oil congeals in cold weather, or which can be ruptured by gunfire. Developed at Thomas A. Edison, Inc., West Orange, N. J., the measuring system has only two components: a pressure transmitter mounted on the engine, and an indicator in the pilot's compartment. In the transmitter, a metal bar attached to a diaphragm responds to changes in oil pressure. Variations in the electrical field are then translated into readings in the indicator. Pressure readings in temperatures from —65 to 450 F can be measured.

(*Continued on page 7*)


Manual override safe against accidental actuation
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Large junction box
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Quick removal of valve from sub base

For Machine Designers Who Want More Than Just 'JIC' Compliance, the Crescent® 4-Way Valve

®Product of Crescent Valve Company for the control of air, water and light oil to 150 P.S.I.

Pointed out on the photo above are the JIC features which are a must for many equipment manufacturers to gain acceptance of their machines in a growing number of production conscious plants. However, they offer obvious advantages even where they are not specifically demanded. Furthermore the JIC type Crescent solenoid is completely interchangeable with standard solenoids for the convenience of those manufacturers who want the JIC features available only for required application.

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COMPACTNESS

Space, labor and materials savings have been pointed out to us by many equipment manufacturers as benefits from Crescent's compact design.

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Crescent valves can be converted to any practical current or voltage AC or DC by a simple coil change.

NO COIL BURNOUT

Short stroke, pilot operation and a generous power margin prevent overheating, overloading and the resultant coil burnout.

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Because many hydraulic functions require CONTROL that responds to the operator's skilled hand and mind

PROVIDE THAT CONTROL

WHERE	WHY	HOW
Initial setting of dies in molding presses	Fast advance of ram (full flow) Gentle approach on die (throttling)	No spools or poppets to obstruct flow or yield to it with a bang
Railroad maintenance equipment, Lift gates, Lift trucks	Careful positioning (throttling) Holding in a desired position (leakproof)	Handle moves evenly, can be stopped at any desired degree of flow Shuts off internal port to port leakage so there is no need for auxiliary lock check valves.
Production test equipment	Accuracy (leakproof) No delay (quick acting–full flow)	Shear-Seals are wear compensating, remain leakproof for millions of cycles Quarter turn opens round tubular flow passages
Oil well blow out preventers	Dependability (no freeze-ups) Pressure remains on (leakproof)	Shear-Seal Valves always move freely–after long inoperative periods–or with dirt or pipe scale in the lines No power loss from internal leakage
Your hydraulically operated machine	To improve your product and reduce its cost	Improved CONTROL Save auxiliary equipment and labor Can be modified to suit

Ask for bulletin 0-5

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5125 Alcoa Avenue, Los Angeles 58, California

Developments to Watch

SUBSTITUTE HIGH TEMPERATURE ALLOYS. . . .

. . . .to replace those using such strategic metals as nickel, cobalt, and columbium, have been further refined in a program now under way at the Cornell Aeronautical Lab., Buffalo, N. Y. (Developments to Watch, p 5, January 1956). Cornell's alloy consists of a modified 316 stainless with the carbon varied as a base, to which is added titanium and boron. This is solution heat treated and rolled at 2300 F. The 100 hr rupture strength at 1500 F of this alloy is 30,200 psi. Without rolling it is 16,200 psi. This compares with 8,500 psi for the unmodified 316 stainless and 25,000 psi for Inconel X. The Navy, who sponsored the Cornell project, is interested in getting a commercial heat of the alloy, and is presently soliciting various high temperature alloy users for their interest in evaluating the alloy.

TO A MAGNESIUM BASE GREASE. . . .

. . . .has been added small amounts of a sodium soap and a lithium soap. These additions now prevent the magnesium grease from becoming hard and separating oil under conditions of sustained high temperatures. This formerly was the only bad quality of a grease that otherwise had good appearance and resistance to shear breakdown. The combination of the new properties, according to Esso Research and Engineering Co., makes the new grease compositions applicable to the sealed bearings of electric motors, railroad anti-friction bearings, and automotive bearings

A LIQUID METAL THAT FLAMES IN AIR. . . .

. . . .appears to have application as a rocket fuel, or as a possible igniting agent for rocket and jet engines, and as an additive for jet engine fuels to maintain flame propagation at very high altitudes and high speeds. Only a small amount will be needed to relight a jet engine after a flameout. The liquid metal, aluminum trimethyl, was developed by the Rocky Mountain Research, Inc., Denver, Colo. The concern feels that with the fuel in a liquid form, it overcomes a problem encountered by the National Advisory Committee for Aeronautics in tests with aluminum powder and aluminum rod to fuel a ram jet engine. Aluminum trimethyl melts at —59 F; is stable at high temperatures and pressures, and can be stored indefinitely; is noncorrosive to iron, steel and other metals; reacts with water and other oxygen-containing compounds; and is used as a polymerization catalyst in new isoprene and polyethylene processes.

DIP COATING OF ELECTRONIC COMPONENTS. . . .

. . . .with polyester resins is a new method developed by Bakelite Ltd., 12 Grosvenor Gardens, London, S. W. 1, England, that is reported to be fast, simple, adaptable to high production lines, and reliable over a temperature range of —40 to 300 F. The components to be treated are preheated to 210 F just long enough to get even heating throughout, and to drive off the moisture. Any components containing phenolic resin bonded sections require the preheat temperature to be at least 270 F to remove the free phenol. The preheated components are immersed, while still hot, in the resin and withdrawn slowly. For components of intricate shape a withdrawal rate of 1 in. in 5 sec gives a good coating of high dielectric strength. The coating is allowed to gel, and the component is redipped. Two dips will give a coating of $\frac{1}{32}$ in. When cured for 5 min at 230 F, such coatings have shown a breakdown voltage better than 10 kv.

(Continued on page 9)

satisfied customers keep coming back!

Here's a lady pleased pink with a new dishwasher . . . so enthusiastic a booster for someone's product she can hardly wait to tell about it, and a sure-fire prospect for future appliance needs. Chances are that a Packard Electric motor has a lot to do with her satisfaction, for Packard motors deliver quiet, dependable, long-lasting performance that's bound to please.

For more than 39 years, Packard Electric craftsmen have been building fractional horsepower motors that lead to one satisfied customer telling another. Packard builds a lot of satisfaction into every motor . . . and there's nothing better than a satisfied customer to boost both reputation and sales.

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Packard Electric Division
General Motors, Warren, Ohio

Developments to Watch

LAYERS OF NICKEL AND CHROMIUM. . . .

. . . .alternately deposited, are transformed into a homogeneous nickel-chromium alloy by the diffusion of the two metals at 1800 F. In work done at the Battelle Memorial Institute, Columbus 1, Ohio, to determine the resistance of several types of electroplates to oxidation at elevated temperatures, it was observed that neither nickel nor chromium alone could withstand oxidation as well as their diffusion alloy could. Nickel and chromium alone oxidized at the same rate, which decreased as the length of exposure to the oxidizing atmosphere increased. The diffusion alloy oxidized slower than either one, but faster than a wrought nickel-chromium alloy. The diffusion alloy's higher oxidation rate is accounted for by grain-boundary diffusion and internal oxidation. Molybdenum could be completely prevented from diffusing through the electroplating by plating a thin gold barrier layer to the first chromium plate, and then plating the gold with alternate layers of chromium and nickel.

THE INCREASING TURNOVER OF ENGINEERS IN INDUSTRY. . . .

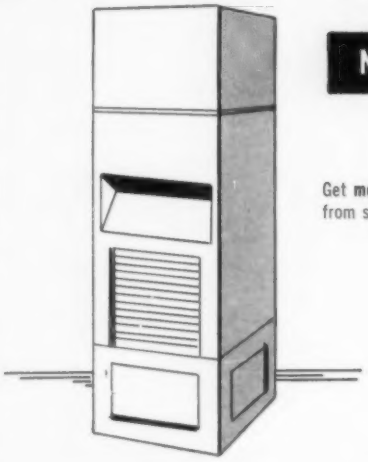
. . . .has been blamed on management's failure to tangibly demonstrate that its engineers are as important as it publicly professes them to be. In a recent survey, it was found that only 24 percent felt that management considered the engineer as a professional; 22 percent felt that they were of importance to their company; and 37 percent felt that the personnel politics in management did not help their professional contributions. A study of salary and working conditions made by the National Society of Professional Engineers revealed some of the causes of the poor morale of engineers: a poor salary review system; no fair or clear-cut system for promotions; no recognition by management of the professional accomplishments of its engineers; inadequate opportunities for advanced study; working conditions that contribute to inefficiency and are not in keeping with the engineer's dignity and professional status; and failure of companies to give the promised opportunities for varied assignments to contribute to professional growth.

AND IN ADDITION. . . .

. . . .The North American F-100A Super Sabre, the first plane to use titanium in the initial stage, uses about six times as much titanium as the F-86D Sabre; North American used 80 per cent of all the titanium alloy sheet produced in the U.S. until 1954, and presently uses more than 50 per cent. . . . More than 4-billion pounds of plastics of all types will be used in 1956 compared to 1-billion pounds ten years ago; consumption of reinforced plastics in 1956 will be at least 50 per cent above the 1955 level, the previous record high. . . . The U.S. Supreme Court upheld by a vote of 4 to 3 the District Court's dismissal of the government's complaint that the du Pont Co. monopolized the cellophane business. . . . The final tabulation of corporate mergers in the U.S. in 1955 showed a total of 846, of which 689 were in the manufacturing and mining industries; one-third of the mergers of this group were by acquiring companies whose assets were at least $50-million, and almost 37 per cent were by acquiring concerns with assets from $10 to $50-million. . . . The British are making plans for the construction of a nuclear power plant to be used in a submarine. . . . A German firm has developed an accessory which automatically makes telephone connections; after a punched card with the desired number has been inserted into the accessory, dialing takes place automatically, and can be repeated, if the number is busy, by pressing a button. . . . A plastic bicycle pump only 4½ in. long and weighing 5 oz is being marketed by the Universal Metal Products Ltd., Salford, Lancashire, England.

under new A.G.A. approval requirements for gas-fired heating equipment . . .

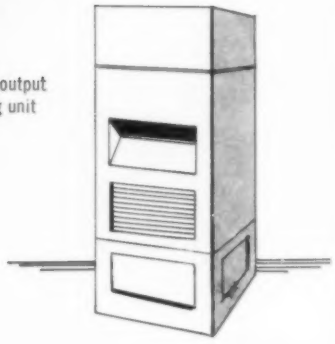
You can gain cost-saving advantages with Armco ALUMINIZED STEEL



Now with ALUMINIZED STEEL

Get **more** BTU output from same size unit

Get present BTU output from **space-saving** unit



New A.G.A. approval requirements permit use of hot-dip aluminum coated steel at operating temperatures up to 1030°F, plus room temperature, in heating elements of gas-fired heating equipment. This is an increase of 225°F over the old maximum.

These new approval requirements open the door to manufacturers who want to take full advantage of the heat- and corrosion-resisting properties of Armco ALUMINIZED STEEL Type 1. If you make gas-fired heating units, here's what this special aluminum coated steel offers you:

- **more BTU's from same size unit**
- **same BTU's from smaller unit**
- **space-saving units to meet modern trend**
- **lower cost than for any other heat-resisting material permitted at comparable temperatures**

HERE'S WHY:

Independent tests show that Armco ALUMINIZED STEEL stands up longer than any metal in its price class under cyclic high temperature heating and cooling in the presence of either sulfur-free or sulfur-bearing gases. Years of use by manufacturers of heating equipment back up these tests.

If you make appliances that require resistance to heat and corrosion consider Armco ALUMINIZED STEEL Type 1. Just write us at the address below for full information about this Armco Special Steel.

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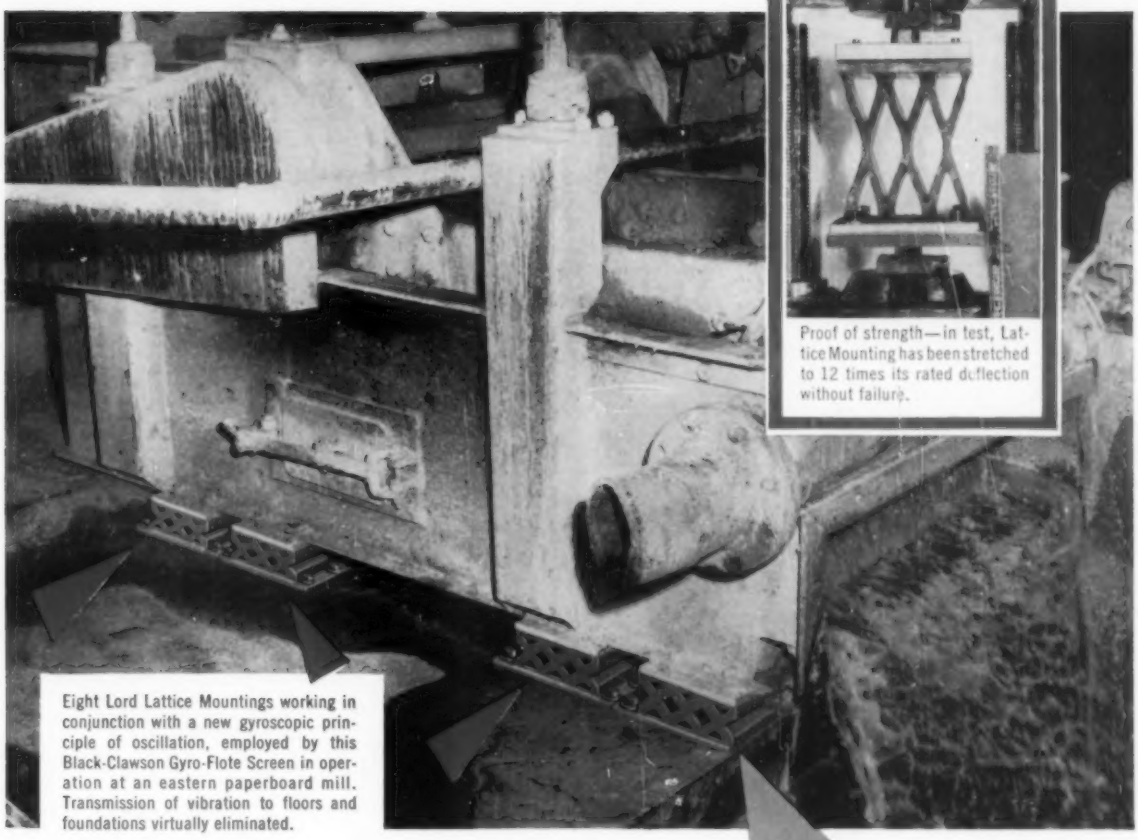
1876 CURTIS STREET, MIDDLETOWN, OHIO

SHEFFIELD STEEL DIVISION • ARMCO DRAINAGE & METAL PRODUCTS INC. • THE ARMCO INTERNATIONAL CORPORATION



Proof of strength—in test, Lattice Mounting has been stretched to 12 times its rated deflection without failure.

Eight Lord Lattice Mountings working in conjunction with a new gyroscopic principle of oscillation, employed by this Black-Clawson Gyro-Flote Screen in operation at an eastern paperboard mill. Transmission of vibration to floors and foundations virtually eliminated.

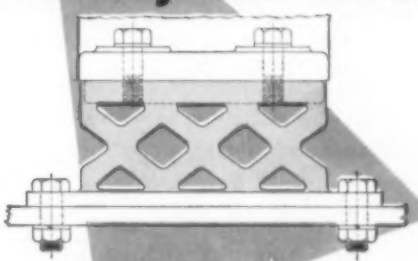
how to isolate heavy-duty machinery vibrations

LORD LATTICE MOUNTINGS PROVIDE FLEXIBLE SUPPORT—
DAMPEN LOW FREQUENCY, HIGH AMPLITUDE VIBRATIONS

Efficiency-destroying machine noise and vibration can be effectively reduced by using LORD Lattice Mountings. Placed under vibrating machinery, they absorb intermittent or continuous pounding, protect performance. Installation is a simple bolting operation using tapped holes in the upper plate and through holes in the lower plate of the unit.

The patented lattice design of the flexing element, perfected by LORD research and engineering, provides soft spring rate characteristics in all directions with good horizontal stability. This element is permanently bonded to steel plates, forming a simple, one-piece unit that *never* requires maintenance.

LORD Lattice Mountings are available in load ratings from 250 to 3,000 pounds per mounting. A complete description is contained in Bulletin No. 701. For your copy, or other information, contact your nearest LORD Field Engineer or write the Home Office, Erie, Pennsylvania.



Installation diagram shows how Lattice Mountings provide a flexible but rugged base for heavy plant equipment. Installation of long-lasting mountings is easy and quick.

Lord Lattice Mountings are covered by U. S. Patent Nos. 2322193 and RE22280.

LORD MANUFACTURING COMPANY • ERIE, PA.

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"In Canada—Railway & Power Engineering Corporation Limited"

Let all these sealing engineers help you design-in oil seals

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The finest oil seal counsel anywhere is yours for the asking. Just pick up the phone and call the nearest National Oil Seal Engineering office. You'll get complete, current information on newest seal developments, plus the help of the entire National Oil Seal Engineering group. Field and factory, these men devote their entire lives to seals. They have seen literally thousands of sealing problems through to a successful solution.

Let National's three decades of sealing experience help you. Call now.

Specify seals at the drawing-board stage—always!

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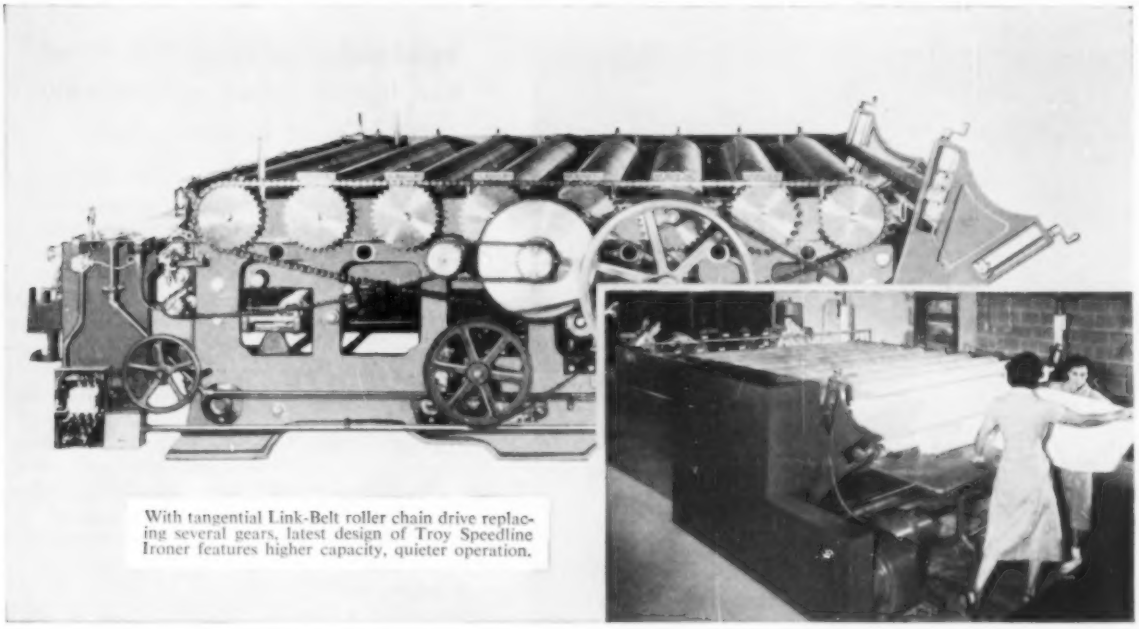
3879

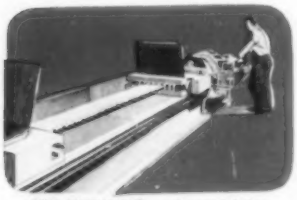
These EXTRAS make Link-Belt Roller Chain

a credit to your machine

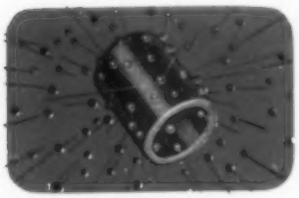


With tangential Link-Belt roller chain drive replacing several gears, latest design of Troy Speedline Ironer features higher capacity, quieter operation.

LOCK-TYPE BUSHINGS (applied on a range of sizes) end a common cause of stiff chain.



PRE-STRESSING of multiple width chain provides uniform load distribution.



SHOT-PEENED ROLLERS have greater fatigue life, added ability to withstand impact.

INCLUDE Link-Belt Precision Steel Roller Chain in your design—and you've a better machine to show for it. Vital extras added to top-standard manufacturing methods give this chain an edge in strength and durability . . . longer service life.

For wide design flexibility, Link-Belt roller chain covers the range of single and multiple widths—¼ through 3-in. standard pitch and 1 through 3-in. double pitch with sprockets of corresponding sizes. The 148-page Data Book 2457 furnishes complete application details. Ask your Link-Belt office for a copy.

Remember Link-Belt, too, for all other drive and conveying chain. Silent, cast, combination, forged and fabricated steel chains — sizes and types for all requirements are included in this complete line.

LINK-BELT

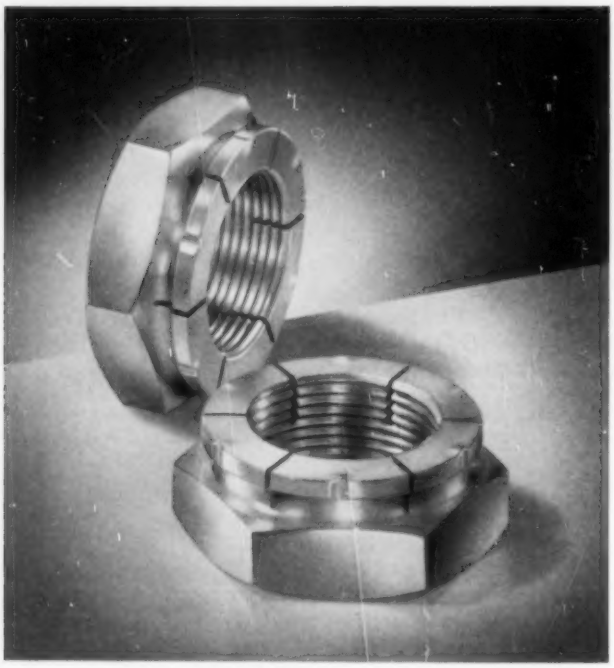
14.040

CHAINS AND SPROCKETS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

Silent Chain | LXS Steel Chain | Detachable Steel Link-Belt | S-815 Flat-Top Chain | Cast and Cut-Tooth Sprockets

Flexloc thin nuts save space, weight and production time



Self-locking nuts are 30% lower and lighter; speed up assembly with hand or power tools

Self-locking FLEXLOC thin nuts are 30% lower than regular height locknuts of the same nominal diameter. They fit into spaces where regular height locknuts will not go. You can design lighter, more compact units with them.

Where you must reduce weight in a completed assembly, you can save by using shorter bolts with these lighter nuts. And you save production time. The length of engagement of mating threads is shorter: fewer revolutions of hand wrenches or power nut runners are needed to seat them.

FLEXLOC nuts are of 1-piece, all-metal construction. You can use a FLEXLOC fully seated as a locknut or at any point along a bolt as a stop nut. Once the threads in the resilient locking section are fully engaged, the FLEXLOC grips the mating threads with uniform locking torque wherever wrenching stops. Since there are no nonmetallic inserts to come out or deteriorate, the locking life of a FLEXLOC is virtually unlimited.

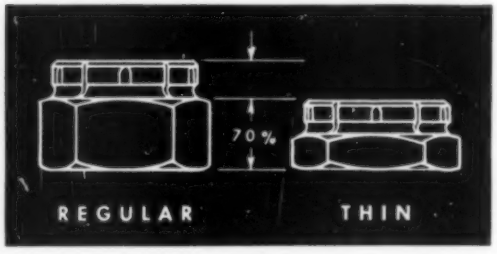
Your authorized industrial distributor stocks FLEXLOC nuts in a variety of sizes, materials and finishes. Consult him for details. Or write us for information about your special locknut problem. Flexloc Locknut Division, STANDARD PRESSED STEEL CO., Jenkintown 28, Pa.

SPECIFICATIONS
FLEXLOC THIN NUTS

NATIONAL COARSE THREAD—U.S.S

SIZE	A INCHES	H INCHES	WIDTH ACROSS CORNERS	WEIGHT PER 1000 NUTS
6-32	.312	.125	.361	1.8
8-32	.344	.172	.397	2.8
10-24	.375	.172	.433	3.3
¼-20	.438	.203	.505	5.4
5/16-18	.563	.250	.649	11.6
⅜-16	.625	.265	.722	14.9
7/16-14	.750	.312	.866	24.9
½-13	.813	.312	.938	28.4
9/16-12	.875	.359	1.010	36.1
⅝-11	1.000	.391	1.155	54.1
¾-10	1.125	.406	1.299	69.2
⅞-9	1.312	.469	1.516	107.5
1-8	1.500	.563	1.732	171.6
NATIONAL FINE THREAD—S.A.E.				
6-40	.312	.125	.361	1.8
8-36	.344	.172	.397	2.8
10-32	.375	.172	.433	3.3
¼-28	.438	.203	.505	5.4
5/16-24	.500	.250	.577	8.7
⅜-24	.563	.266	.649	11.5
7/16-20	.625	.312	.722	14.9
½-20	.750	.312	.866	21.7
9/16-18	.875	.359	1.010	36.2
⅝-18	.938	.391	1.082	42.4
¾-16	1.063	.406	1.227	54.5
⅞-14	1.250	.469	1.443	84.6
1-14	1.438	.563	1.660	136.3
1 1/16-12*	1.625	.625	1.876	193.5
1 1/4-12*	1.813	.750	2.093	296.0
1 3/16-12*	2.000	.812	2.309	389.0
1 ½-12*	2.187	.875	2.526	498.0

*Steel only (plain or cadmium plated) in stock sizes.



FLEXLOC thin nuts are 30% lower than regular height locknuts. There is a corresponding saving in weight. In sizes through 5/16 in., thin FLEXLOCS meet tensile strength requirements for regular height locknuts. FLEXLOC nuts can be made in the thin type because every thread, even those in the locking section, carries its full share of the load. There are no nonmetallic inserts to waste head space or weaken the structure of the nut.

Standard FLEXLOC self-locking thin nuts are available in plain or cadmium plated alloy steel, for use in temperatures to 550°F; in plain or silver plated corrosion resisting steel, for temperatures to 750°F; and in brass and aluminum, for temperatures to 250°F.

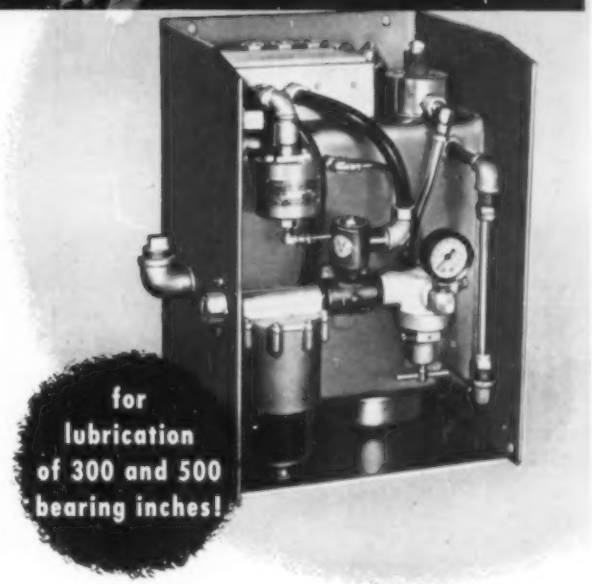
STANDARD PRESSED STEEL CO.

FLEXLOC LOCKNUT DIVISION SPS

JENKINTOWN ■ PENNSYLVANIA

Now! Design Automatic Lubrication into your largest machines!

2 new ALEMITE OIL-MIST AUTOMATIC LUBRICATION MODELS



Greater capacity . . . greater coverage . . . greater savings! Now the largest machines can have moneysaving, timesaving Alemite Oil-Mist Automatic Lubrication! These two new models offer greater capacity for lubricating up to 300 and 500 bearing inches! They are the same type of famous Alemite Oil-Mist systems already proved on countless machines in all types of industry.

Alemite Oil-Mist Lubricators atomize oil into mist and distribute it through tubing to all types of lubricated mechanisms—anti-friction and plain bearings, gears, slides, ways, chains, cams, and rollers. Amazingly simple, continuous and fully automatic . . . Alemite Oil-Mist eliminates the waste and uncertainties of the "human element" in lubrication.

Design more efficient, more economical, foolproof automatic lubrication into your machines. Mail coupon below for full details!

8 Advantages of the ALEMITE OIL-MIST System

1. Continuous Lubrication—Constantly deposits fresh, clean film of oil on all surfaces of all bearings in the system.

2. Fully Automatic Lubrication—Can start and stop with operation of machine switch.

3. Elimination of Guesswork—No bearing can be overlooked, nor overlubricated! Every bearing picks up only as much Oil-Mist as it needs. Eliminates waste.

4. Reduction of Bearing Temperatures—Acts as bearing coolant, can lower bearing temperatures as much as 20° F.

5. Reduction of Types of Oil—Reduces number of oils that must be stocked, handled, and applied.

6. Elimination of Downtime—All bearings in the system are constantly lubricated while machines continue to operate. Production goes up!

7. Extension of Bearing Life—Multiplies bearing life many times. Life of grinding machine bearings has extended from 400 to 7,000 hours!

8. Less Oil Consumption—about 1/10 the amount consumed by any other lubrication method!

Alemite Oil-Mist Lubricates ALL Types of Mechanisms

Anti-friction Bearings | Plain Bearings | Chain | Gear | Gear Cases

ALEMITE OIL-MIST

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Alemite Division of Stewart-Warner, Dept. T-86
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☐ Please send me a FREE copy of your new and complete Alemite Oil-Mist catalog.

☐ Please have your Alemite Lubrication Representative arrange a no-obligation demonstration.

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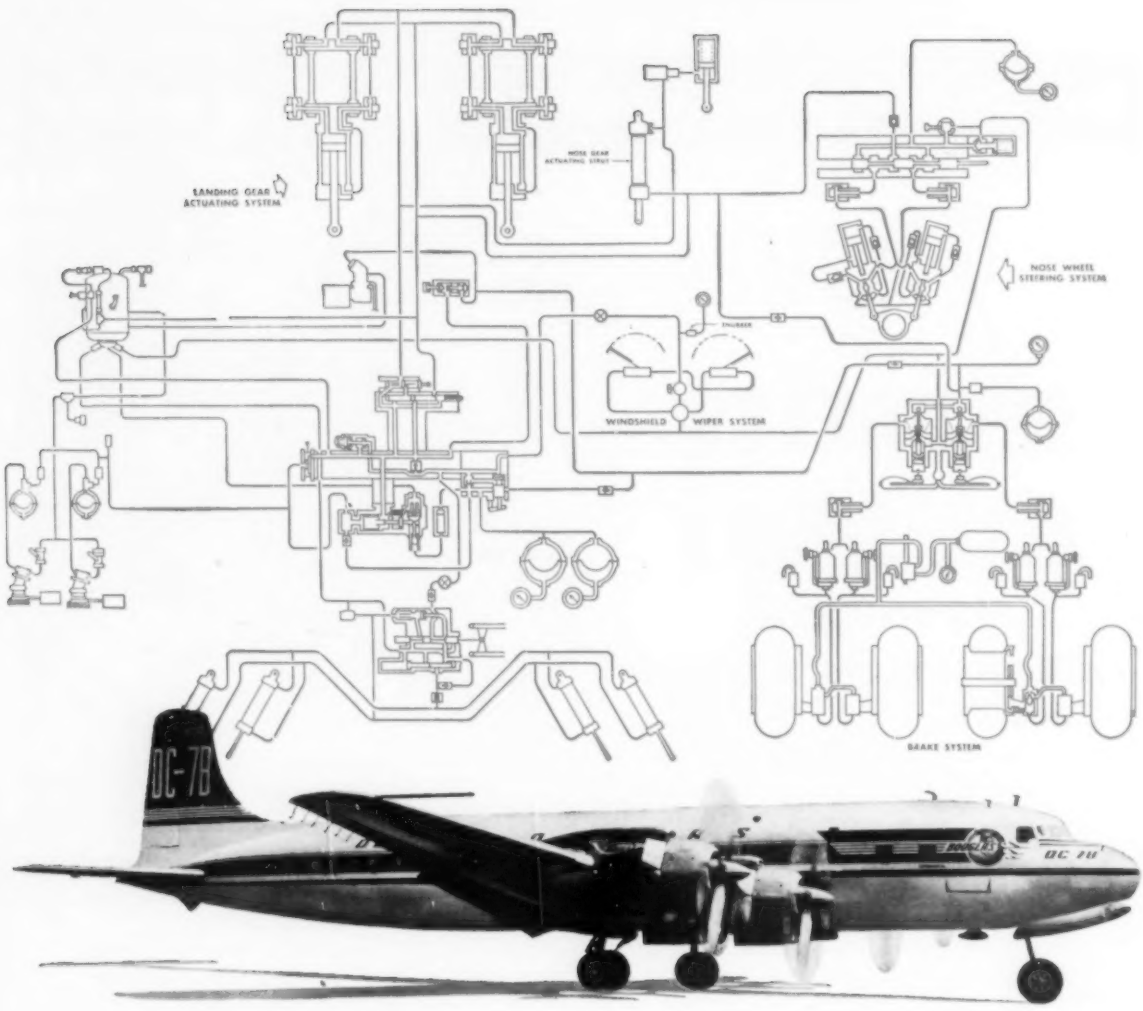

Enjay Butyl rubber— vital artery in newest airliners

Douglas chooses Enjay Butyl for rubber components of the hydraulic systems in many of its famous DC-7 airliners. These components, which help assure the dependable operation of everything from wing flaps to landing gear, are proving over millions of air miles their durability and resistance to wear.

Versatile Enjay Butyl rubber may well have a place in *your* operation. It will pay you to investigate the many technical advantages it has over other types of rubber. Its price and ready availability are advantages, too. For full information, and for technical assistance in the uses of Enjay Butyl, contact the Enjay Company today.

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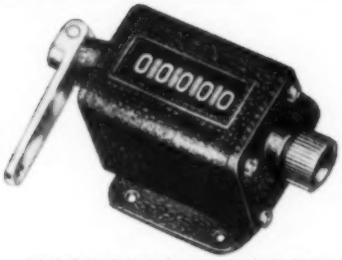
Why is COUNTROL

important in every business today?

Countless times a day, every business needs to know "how many? . . . how much? . . . how far? . . ." and many other questions that can be answered only by facts-in-figures. But how to get these figures . . . from so many different machines, processes, operations and systems? Veeder-Root Counters are doing it every day, by means of:



MECHANICAL COUNTING

Small Resets count strokes, turns, or pieces . . . are used by thousands for moderate duty in parts inspection, quality control, conveyors, machine tools, light presses, etc.

HAND COUNTING

Where objects or units cannot be counted electrically or mechanically, hand-operated counters like this Hand Tally do the job. For instance, quick spot checks of production or performance, traffic count, inventory, etc. Fits palm of hand, counts one for each pressure of thumb lever, resets to zero by turning knob.

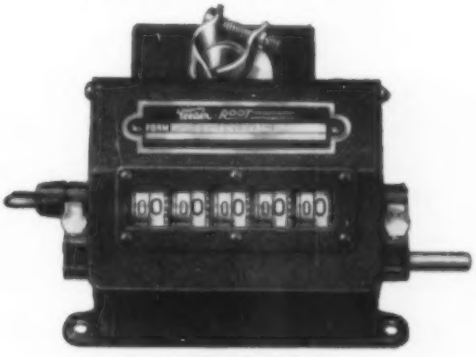
Insist on Standard

VEEDER-ROOT COUNTERS

from your Industrial Supply Distributor

ELECTRICAL COUNTING

These remote-indicating counters bring your production machines as close as your office wall. AC or DC, they can be connected in series with any simple switch, and will transmit production figures *instantly* over any distance. May be panel-mounted in groups.



CONTROLLING

Set it for the exact number of turns, pieces, or operations required . . . and this Predetermining Counter will control the run *exactly* . . . preventing over-runs and shortages. When the predetermined number is reached, counter will light a light, ring a bell, or actuate a stop-motion.

IN SUM: *If it can be counted or controlled . . . count on Veeder-Root to do it. Get in touch with your Industrial Supply Distributor for standard counters for application to your production machines and processes. And get in touch with Veeder-Root for counters to be built into original equipment.* **Veeder-Root Inc., Hartford 2, Connecticut.**

Craftsmanship of the 20th Century

MONSANTO

The speed with which new products pass through the designing stage to final marketing is one of today's industrial phenomena. One factor which has contributed heavily to this is the availability of a wide range of plastic materials with highly usable combinations of properties. And, collaterally, there are the custom molders whose working knowledge and craftsmanship in plastics translate the manufacturer's designs and plans into highly serviceable, highly attractive finished articles. Read how one of America's leading appliance manufacturers collaborated with the custom molder to produce the part that "makes" his new appliance.

New handle of Resinox phenolic plastic houses "the brain" of the new Sunbeam Fry-Pan

DESIGN OBJECTIVES To design the handle for the Sunbeam Fry-Pan, an aluminum frying pan, electrically wired to "do its own cooking." To its designers, Sunbeam Corporation of Chicago stressed two things: functional beauty and long service life. Cost, of course, as on all high-volume competitive products, was also a consideration.

MATERIAL SPECIFICATION In the Fry-Pan, the handle is the "brain"—housing the temperature setting controls, signal light, and automatic regulators that govern the 1150 and 1450 watt tubular element sealed in the base of the pan. Specifications dictated that this handle be inserted into the apertures of the thermostat, then sealed in 3 seconds by a Hannifin hydraulic press. Over 30 exhaustive tests were made to screen different materials in the conditions to which the handle would be subjected in use. Surface finish and hardness, resistance to detergents and boiling water, weight, dielectric strength, and durability were all major factors in determining the material. Monsanto Resinox phenolic plastic was selected. A handle molded of this phenolic had a high natural surface gloss, heat-resistance, and inherent color. It could be repeatedly immersed in boiling water with no ill effects . . . was tough and long lasting.

PRODUCTION Prolon Plastics Company, Florence, Massachusetts, a division of Pro-phy-lac-tic Brush Company, was awarded the job of producing the Fry-Pan handles. In addition to an enviable reputation for high quality molding, Prolon had also demonstrated a productive capacity to meet Sunbeam's production rate. For this handle assignment, Prolon engineers decided on Monsanto Resinox 5797. A free-flowing phenolic molding compound, Resinox 5797 has rapid cure and rigid set, two reasons for its wide use for wiring device parts. It produces parts with a very smooth,

Chief Mold Designer for Prolon Plastics Co., Mr. Clyde Morrell.

hard surface. Equally important, Resinox 5797 meets the critical heat requirements on the Fry-Pan where heat is constantly re-applied to this molded handle. Using Resinox 5797, Prolon molded a handle with a life expectancy far exceeding the required 2000 hours. In fact, if the housewife uses her Sunbeam Fry-Pan with its Resinox handle for 7 hours a week, 52 weeks of the year, she can expect over 5½ years of service under such severe usage.

THE FINISHED PRODUCT The popularity of the Sunbeam automatic Fry-Pan is a tribute to the usefulness of this work-saving kitchen appliance. Practical usefulness has been achieved by following the precepts of functional design and simplicity of form. The jet black lustrous handle of Resinox phenolic plastic adds a high note of functional beauty.

Here is one of the hundreds of design and production problems solved by utilizing the facilities of the plastics custom molding industry. If you are considering a design change or new product, investigate plastics, and the design, engineering, and molding facilities available to you through plastics molders, the Craftsmen of the 20th Century. As a major supplier of plastic resins, Monsanto is in a position to introduce you to custom molders who will put their skills to work for you. Write to Monsanto Chemical Co., Industrial Applications Dept., Springfield 2, Mass.

Investigate Monsanto's complete line of phenolic plastic compounds developed for particular applications and sold under the trade name . . .

RESINOX®

MONSANTO

how ARMASTEEL wider scope of

NEW PRODUCT DESIGNS POSSIBLE . . . Due to their unusual physical properties, high machinability ratings, and wide latitude of design, ArmaSteel castings are replacing other materials in today's products. Being a casting material, ArmaSteel can be formed in shapes too complex for the forging process. With ArmaSteel castings, low draft angles, intricate coring, and close dimensional tolerances are possible. Less stock remains to be machined. High tensile strength, damping qualities, and other physical and chemical characteristics are also major factors in ArmaSteel's popularity among product design engineers.

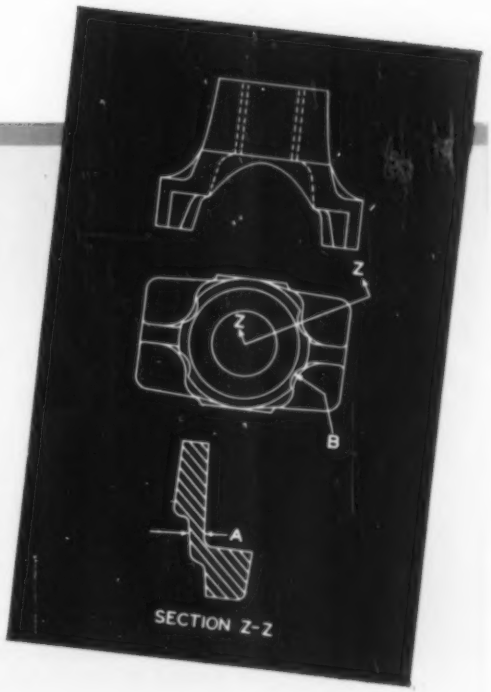
ARMASTEEL IS A PEARLITIC MALLEABLE IRON, possessing many of the physical characteristics of forged low-carbon steel. Because of carbon nodules in the pearlite matrix, the machinability of ArmaSteel castings is 58% better than S.A.E. 1040 steel and compares favorably with S.A.E. 1112. ArmaSteel is produced in three ranges, with tensile strengths from 70,000 psi to 100,000 psi, yield strengths from 48,000 psi to 80,000 psi, and elongations (in 2") from 2% to 4%. Because of these excellent properties, and because it can be either sand cast or shell cast, ArmaSteel provides improved parts for many products, at the same time that it lowers costs. On these pages are two case histories of products that have benefited from ArmaSteel castings . . . perhaps your product can benefit too.

CAST ARMASTEEL IMPROVES AN AUTOMOBILE DIFFERENTIAL CASE

This case forms the support for the driving gears in an automobile. The demands made of such a part are that it be of high strength, that it have the least possible deflection, and that—because it is part of the car's unsprung weight—its weight be held to a minimum to help the riding characteristics. The part must be cast because it is impossible to forge the internal cavity.

ARMASTEEL 86M MET ALL THESE DEMANDS. It has a tensile strength of 70,000 psi, a yield strength of 48,000 psi, and a Brinell Hardness No. of 163-207. Deflection is very low, and ArmaSteel absorbs vibrant energy, thus contributing to quiet operation. The cast ArmaSteel part also allowed the manufacturer to eliminate thrust washers on the pinion gear bearings, reducing costs.

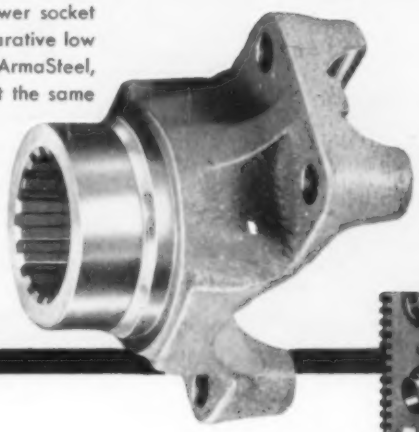
castings allow new and much design



CAST ARMASTEEL REPLACES FORGINGS IN THIS COMPANION FLANGE BECAUSE OF SPACE LIMITATIONS

This part was formerly a medium carbon steel forging. During a re-design of the unit, it was impossible to get the desired strength by enlarging the part, because of design limitations. It became apparent that the draft angles necessary in the forging would not allow proper thickness of metal at point "A". Only a casting could achieve the low draft angles needed, and only a high strength material could meet the design requirements.

CASTINGS OF ARMASTEEL 84M PROVIDED THE ANSWER. ArmaSteel 84M has an ultimate tensile strength of 100,000 psi, and a yield strength of 80,000 psi. ArmaSteel parts tested showed a long fatigue life and minimum deflection under the extreme stress involved. In addition, castings offered a reasonable cost per piece, excellent machinability, and uniformity in production lots. In broaching the spline in the center hole, the manufacturer found that ArmaSteel castings resulted in greatly improved broach life. Draft angles were reduced to 2°, which allowed sufficient clearance (point "B") for the power socket wrench assembly operations. Thus, due to the comparative low cost of castings and the reduced machining costs of ArmaSteel, the manufacturer enjoyed an overall saving and at the same time solved his design and assembly problems.



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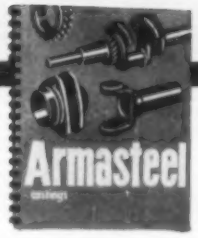
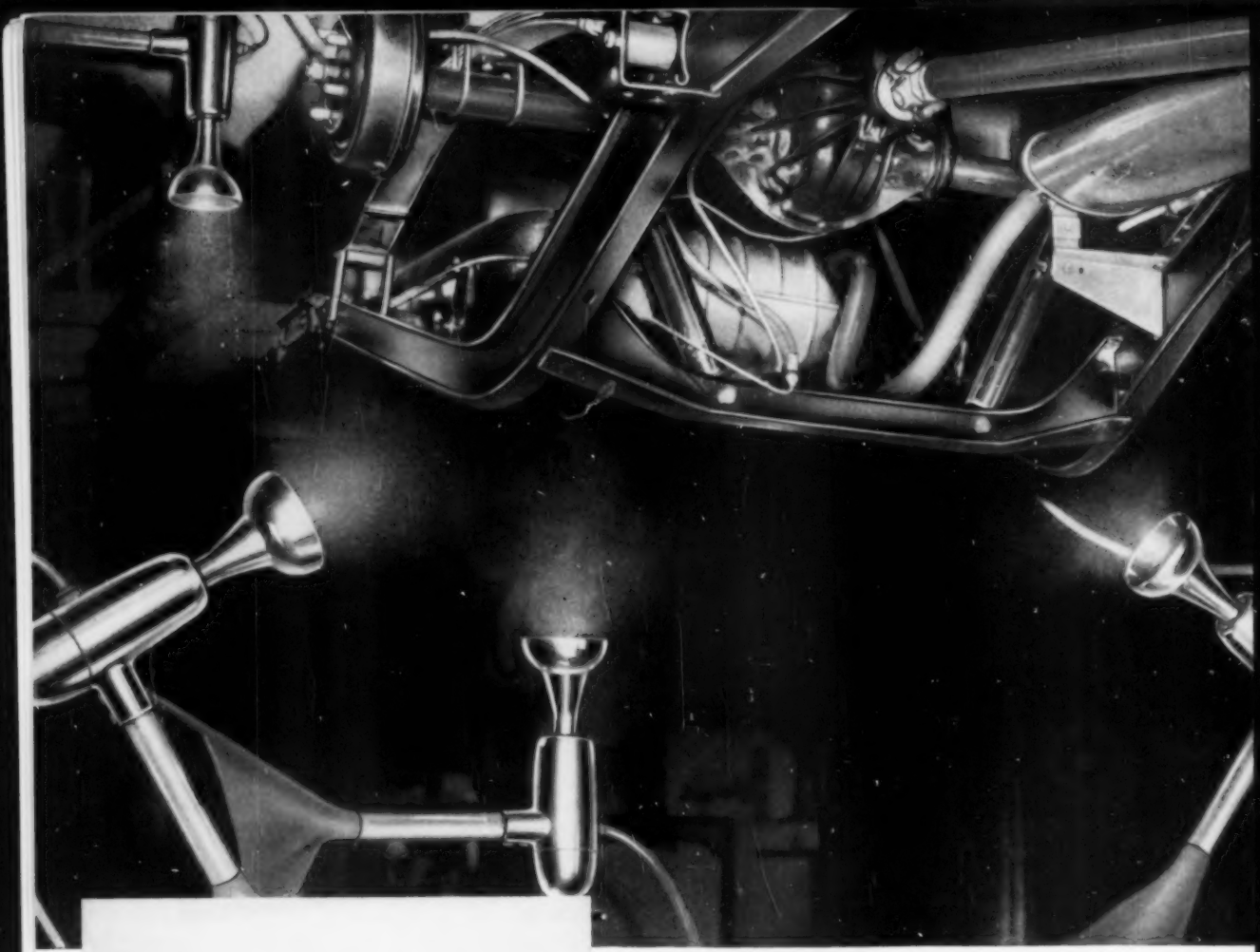


For further information on physical properties and applications of ArmaSteel, write for our complete catalog. Descriptive literature is also available on our shell mold and sand casting processes.

CENTRAL FOUNDRY DIVISION

GENERAL MOTORS CORPORATION • SAGINAW, MICHIGAN • DEPT. 10



R&M MOTOR PARTS AT WORK

A prominent passenger car manufacturer gets eleven times more chassis per gallon—reducing paint and production costs substantially—with the efficient, high-quality electrostatic paint spray process of the Ransburg Electro-Coating Corp., Indianapolis, Ind. Robbins & Myers polyphase motor parts are utilized to atomize the paint spray in an electrostatic field. The spray is attracted to the products, which are grounded through the hanger, producing a high degree of uniformity of finish.

◀ Rugged rotor and stator for a polyphase portable tool. The rotor consists of squirrel cage, embedded in laminated core with bars and end rings of copper, brazed or welded together. The stator has a high-grade silicon steel core with top-quality rag paper used to insulate the coil from the core. The finished winding is taped and thoroughly impregnated with high-grade synthetic resin base varnish to assure trouble-free operation with minimum danger of short circuits and grounds.

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Fractional & Integral h.p. Motors & Generators

Household Fans

Electric & Hand Hoists & Cranes

Moyno Pumps

Propellair Industrial Ventilating Equipment

R & M SPECIALISTS INTEGRATE MOTOR AND MACHINE DESIGNS... TO ASSURE HIGHEST PERFORMANCE

Many factors must be considered in designing a new motor-operated product that will perform its intended functions accurately, economically, and with a low maintenance and failure rate. Much depends on the proper correlation and integration of motor and machine designs. A special knowledge of motor application can be valuable to you. Robbins & Myers motor design specialists can help you solve these problems, to whatever extent you desire.

The exact motor for your machine is worked out quickly and accurately, with systematic methods of designing motors. This might include, for example, the use of R & M's unique "Electrical Slide Rule." Electrical equivalents can be set up on the slide rule to simulate the conditions under which the motor must operate in your product. By this method we are able to investigate hundreds of different design possibilities, assuring the best motor for the job.

In some cases the answers point to a standard motor. And here, R & M offers a wide variety of types and sizes of complete motors or matched motor parts.

In other cases special motors are indicated. R & M is equipped to do a fast, thorough, economical job of custom-designing a motor that's exactly right for your product.

Don't settle for an "off-the-shelf" compromise. Standard or custom-designed, R & M will get you the right answer quickly —with no obligation!

R & M MOTORS AND MOTOR PARTS POWER MANY TYPES OF EQUIPMENT, SUCH AS . . .

Portable Saws	Routers	Nut Setters	Hedge Trimmers
Drills	Screw Drivers	Hammers	Lawn Mowers
Nibblers	Pumps	Polishers	Oil Burners
Lock Mortisers	Compressors	Planers	Surgical Instruments
Valve Grinders	Hones	Portable Grinders	Grease Guns
Vacuum Cleaners	Business Machines	Sirens	Vibrators
Fans	Cast Cutters	Advertising Devices	Die Sinkers
Sanders	Food Mixers	Ventilating Equipment	Waxers

R&M MAKES BOTH!
Fractional-horsepower motors and parts . . . from 1/200 h.p.

If it's an R&M, it's the Right Motor!

Integral-horsepower motors; famous R&M "All-Weather"* with sealed bearings. Up to 200 h.p.

*"All-Weather" is an R & M trademark

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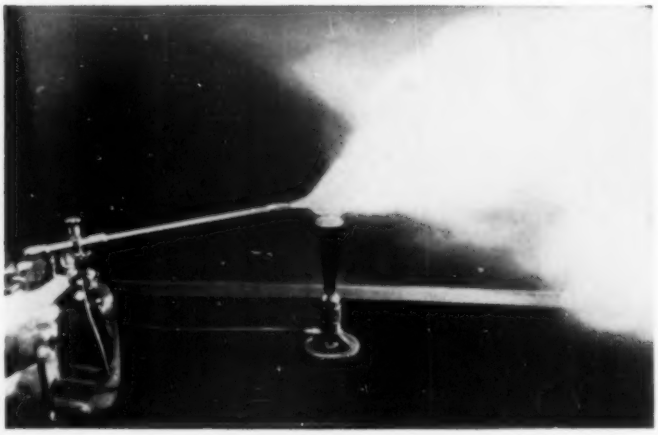
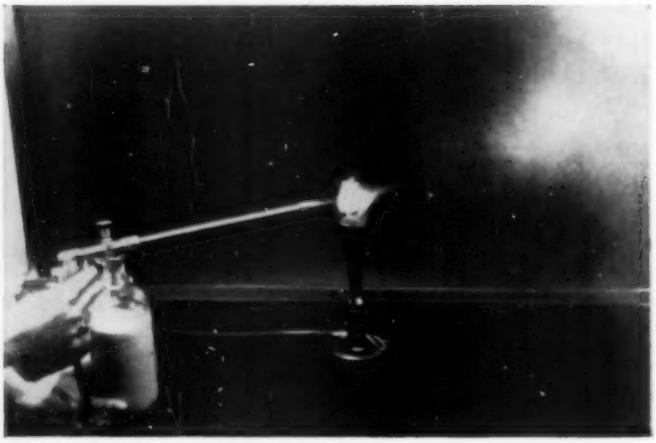


This photo shows the instant combustion taking place when a conventional hydraulic oil of mineral oil type is atomized over a Bunsen burner.



In this photo, Shell Irus Fluid 902 replaces the mineral oil. Note that there is no ignition.

SHELL IRUS FLUID 902

Oil-Base fire-resistant FLUID

SHELL IRUS FLUID 902

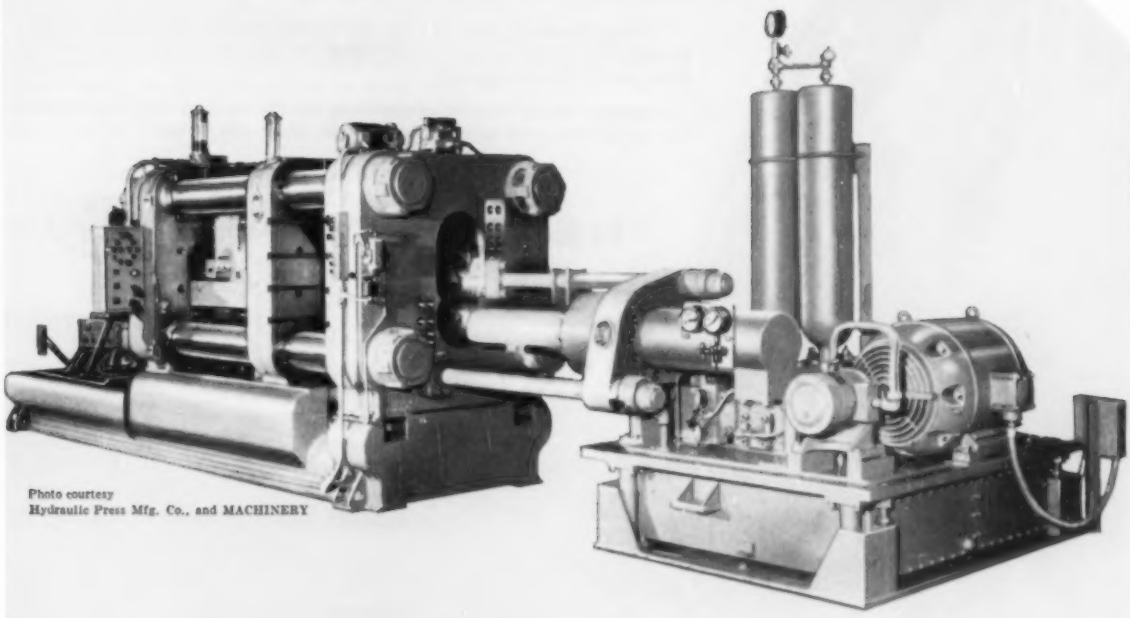


Photo courtesy
Hydraulic Press Mfg. Co., and MACHINERY

AFTER THREE YEARS of intensive research, field application and evaluation, Shell Irus Fluid 902 is now commercially available for use in industrial hydraulic systems. While its cost is far lower than other fire-resistant fluids, its performance is comparable.

No major modification of equipment is necessary. Shell Irus Fluid 902 is a special formulation containing no corrosive ingredients . . . no adverse effect on seals or fittings. It is a direct replacement for hydraulic oils now in service.

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Republic—world's largest producer of aircraft steels—is ready to help you in two ways. First, with the materials needed to combat heat as well as strength-to-weight and corrosion problems. And second, with metallurgical service backed by over a quarter century of experience gained through helping hundreds of designers and manufacturers in all types of industries meet and solve similar problems.

To date two materials, titanium alloys and stainless steels, best qualify to meet the severe service requirements for skin of aircraft and missiles flying at supersonic speeds.

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NEW DEVELOPMENTS create new uses. A unique tank truck with one compartment made of ENDURO Stainless Steel safely handles a corrosive alcohol-water mixture used in turboprop engines. Another compartment, for kerosene, is fabricated from Republic High Strength Steel for extra strength without added weight.

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SOLVING HEAT PROBLEMS is old stuff for ENDURO Stainless Steel. ENDURO's ability to withstand heat without loss of strength has been proved on jet engines where it is used for structural and burner components, rings, exhaust systems, afterburners. Now it is being used for skin material to resist high temperatures at supersonic speeds.

STEEL IS READY

the thermal barrier

Republic is the world's largest producer of alloy, stainless and heat-resisting steels.

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Republic is vitally interested in helping you use Titanium and ENDURO® Stainless and Heat-Resisting Steels. Our metallurgists and engineers are always available, without obligation, to work with your personnel in using these materials to best advantage. The coupon will let us know if you would like one to call.

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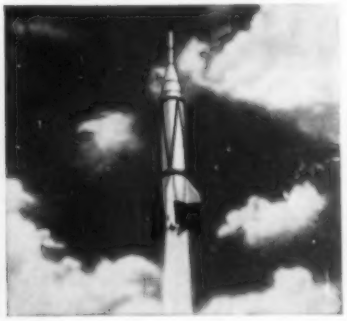

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ACTUAL PHOTOGRAPH

Fact 2 . . . up to 40% less space needed to stock. These new motors take less room in your product, too, because they are more compact in design.

New Westinghouse Design Cuts Motor Weight Up to 50%

. . . one important FACT about the *new* Westinghouse 48-frame fhp motor

Many cost-saving features make the new Westinghouse 48-frame your *best* motor buy. Lighter, smaller and more compact in design, it can be used to advantage in your product.

The lighter motor lets you use lighter mountings, lowering material costs. And it's easier to handle, faster to install on assembly lines. In many cases, your shipping costs will be lowered, too.

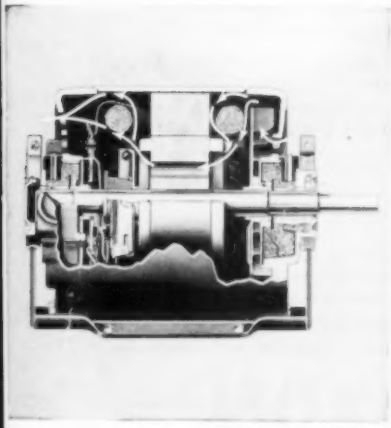
A new, lighter base—either rigid welded to frame or resilient—assures stronger mounting even under severe operating conditions.

It is the only true all-angle mounting motor. Don't expect all these benefits in any other motor.

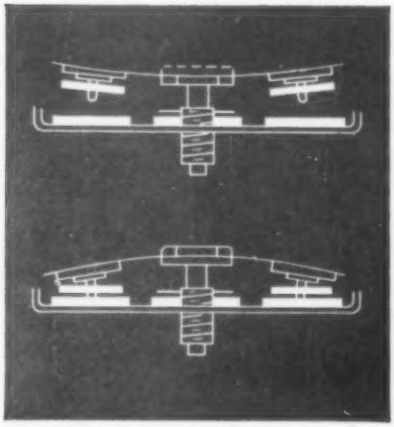
The Man With The Facts, your Westinghouse sales engineer, has all the information about this new fhp motor line. Contact him or write for DB-2801 for complete technical data. Westinghouse Electric Corporation, Small Motor Division, Lima, Ohio. J-03019

YOU CAN BE SURE...IF IT'S

Westinghouse



Fact 3... straight-through ventilation of this new motor insures cooler operation for longer running periods, even at peak loads.



Fact 4... exclusive Thermoguard® overload protection (optional). It opens (top) when overheating occurs... it resets when cool to resume operation.

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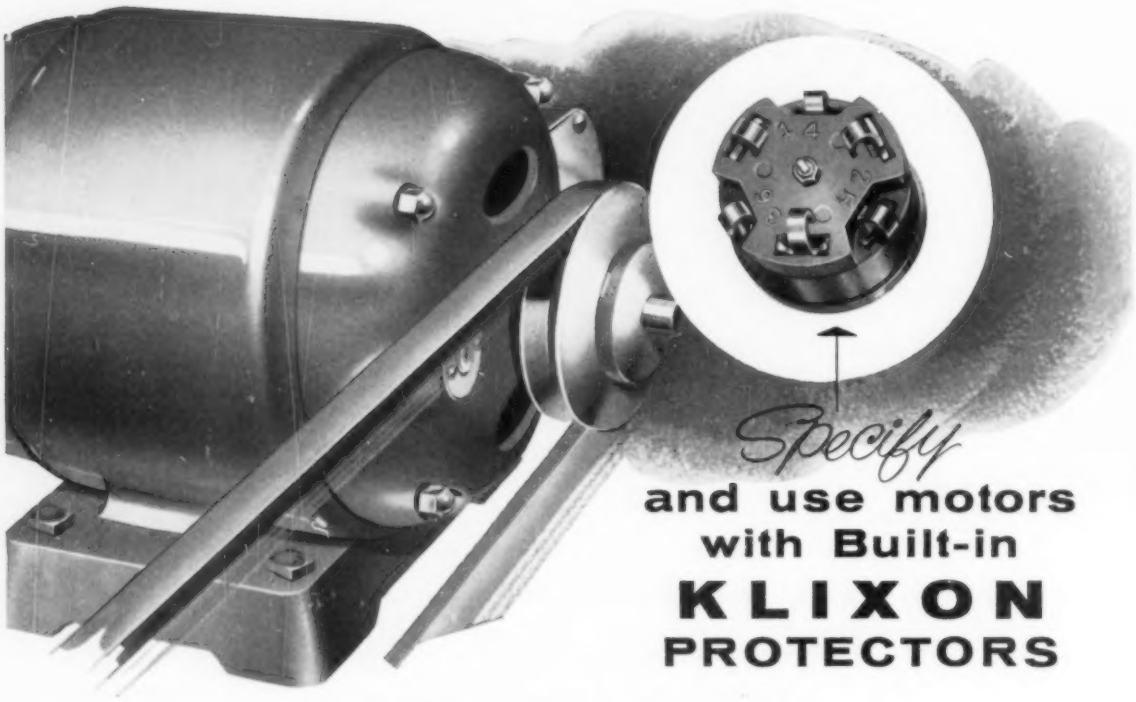

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Now you can get the same dependable protection in 3-phase motors that manufacturers have for years built into single phase motors. This inherent protection is now available to manufacturers of 3-phase motors covering a horsepower range from fractional up through 7½ hp. (600V.)

KLIXON Protectors Prevent Overheating Caused By:
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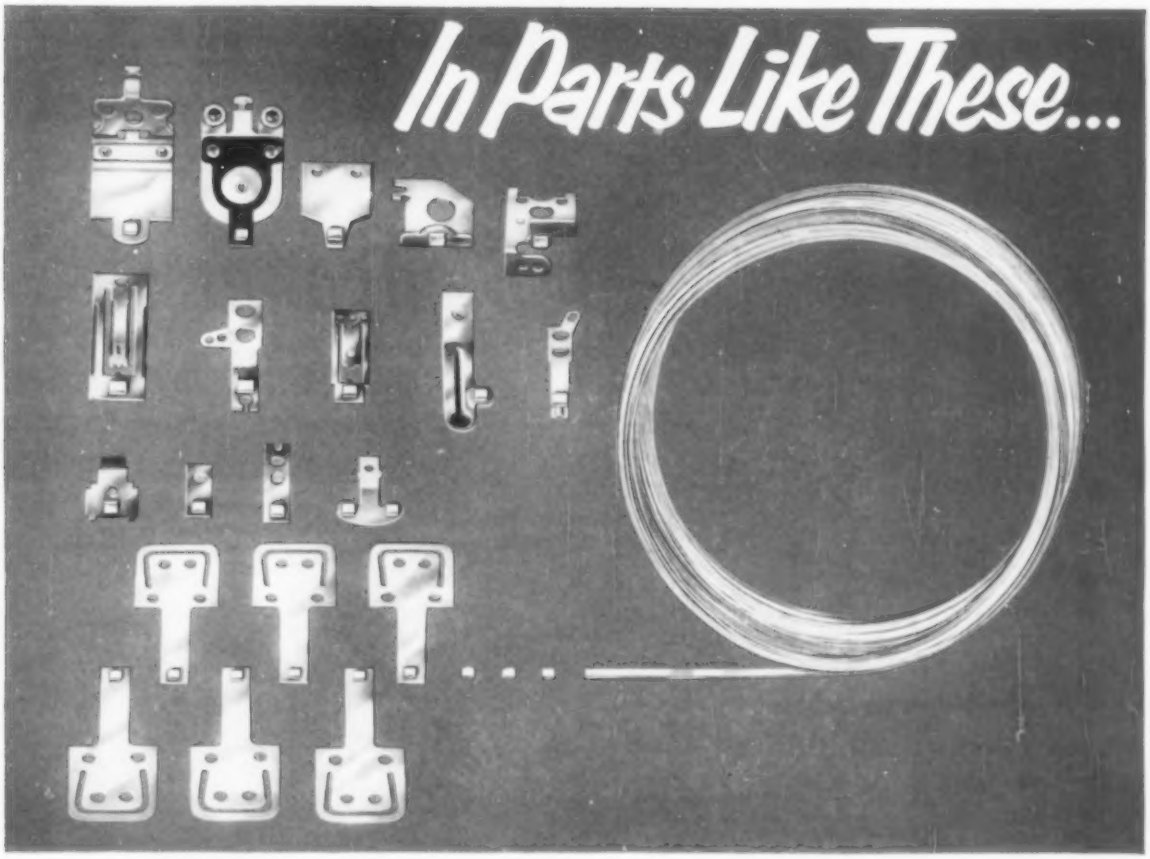

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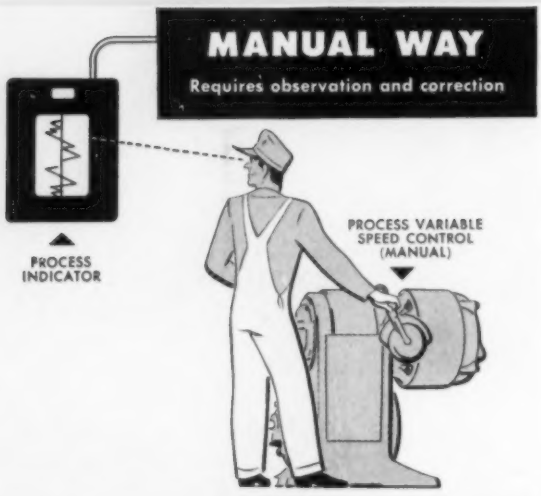
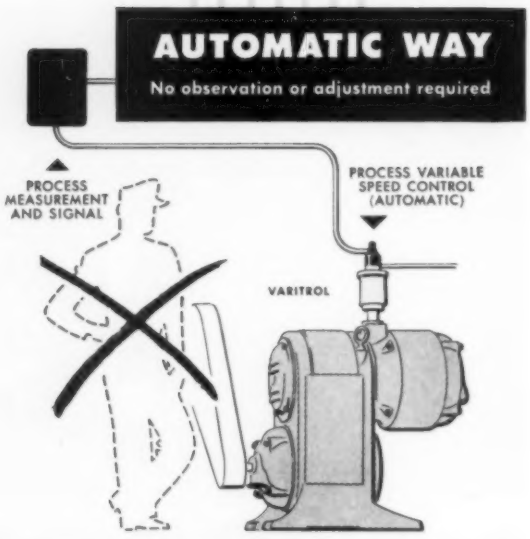
HOW VARITROL AUTOMATIC SPEED CONTROL saves Manpower





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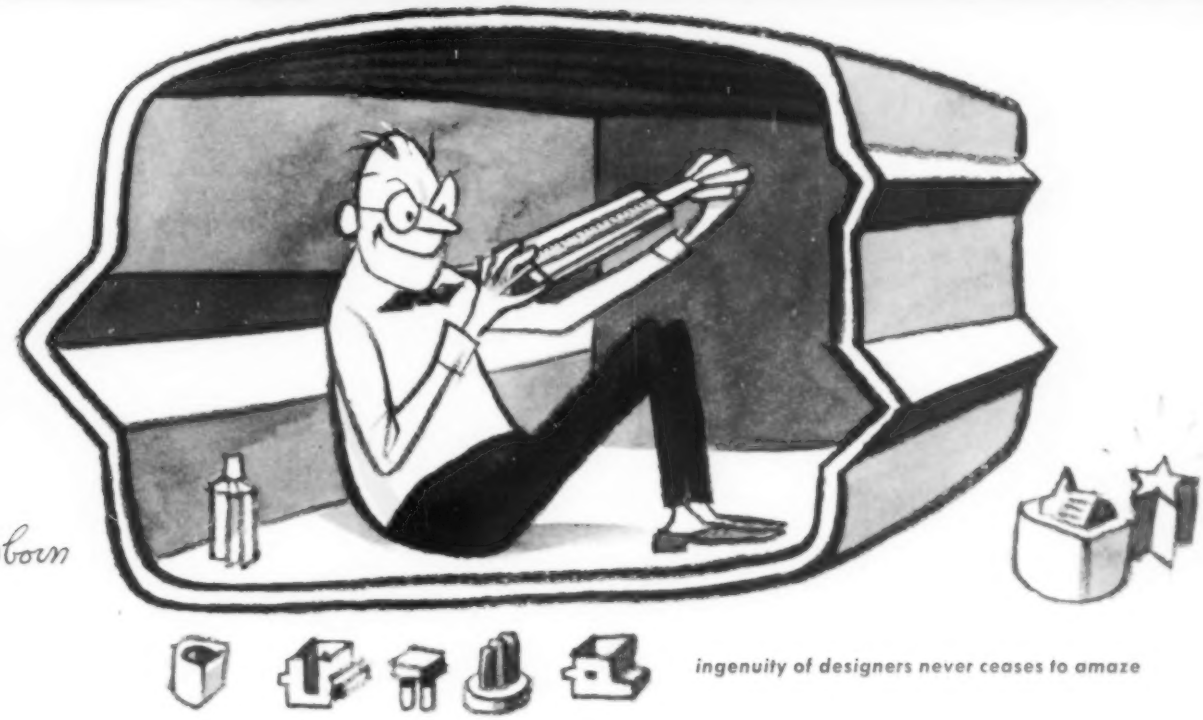


ingenuity of designers never ceases to amaze

Alcoa's Up-to-Dater on Impact Extrusions

News in four pages concerning rules for selecting impacts, finishing techniques, alloy selection, forward-reverse-sideward impacts and some impossible jobs. All solid stuff with very few commercials for tomorrow's design supervisors.

Rules of thumb in lieu of hunches

In the past 35 years of making impact extrusions, we've seen some lulus. Some we thought couldn't be made. Some were new applications and forms that we had never thought of. The ingenuity of designers never ceases to amaze us.

Some of these designers were so familiar with impacts that they just naturally considered them every place where they could save money. Others just had a hunch. Still others tried every other way before they hit on impacts. We don't want you to have to guess. And we certainly don't want you to have to try other fabricating methods. So here are some rules of thumb to help guide your thinking.

1. Parts requiring hollow sections—either tube- or can-shaped with one end closed.
2. Parts with walls or surfaces requiring zero draft.
3. Parts requiring lengths up to eight or ten times the diameter.
4. Parts requiring the strength of forgings.
5. Parts requiring tolerances down to ± 0.005″.
6. Parts requiring ribs, bosses or fins as integral parts.
7. Parts requiring low unit cost in mass production. (Often the savings in machining, fabrication and assembly made by impacts amortize tooling in relatively short runs.)

Where the finish affects the start

There are lots of products that can't go to market unless they've been painted or plated or colored in some manner. Thus, the finish is an important consideration right from the start, and the manufacturing process is often selected on the basis of smoothness of surface. To this end, we point with pride to the smooth texture of Alcoa Impacts. No parting line. No scale. No draft to cut off. Just a lustrous, rustproof surface of about 125 micro-inches, on the average. To this, many manufacturers add paint or lithographed inks (look at tooth-paste tubes). Others anodize in every color of the rainbow.

we point with pride to the smooth texture

advertisement

Forward — Reverse — even Sideways

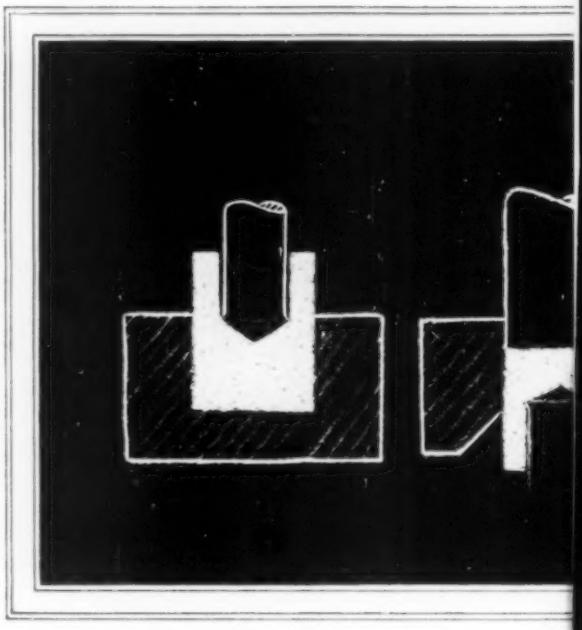
The first contact most designers have had with impact extrusions has been the reverse type. In this method, a metal slug is put in a closed die and struck with a punch. The metal squirts through the annular opening between the punch and the die, following the contour of the punch. This process has been called indirect extrusion, upward extrusion, backward extrusion or reverse extrusion. The last is best known and most accepted.

It is also possible to squirt the metal forward, through the die. Flanged parts with hollow or solid stems are made most economically by this method. This process, too, has lots of names: Hooker process, downward extrusion, direct extrusion and forward extrusion. Here, again, the best-known and most accepted terminology is the last.

Now hang on. It is possible to combine a forward and reverse extrusion in the same place. This forms a part, hollow on both ends and solid in the middle. Like other impacts, it may have flutes, splines and bosses both inside and outside. The parts may be round, oval, square, rectangular or odd-shaped, and either symmetrical or nearly symmetrical about the longitudinal axis.

Still with us? Not only can we impact forward and reverse, at the same time, but we can also go sideways, too. Thus, it is possible to make parts with a central hub having arms or spokes radiating from it. These arms or spokes may also be varied in cross section. Sideways impacts cost more, but designers often are confronted with problems of producing a lot of such pieces. Usually such shapes as impacts would be cheaper than assembly and fabrication.

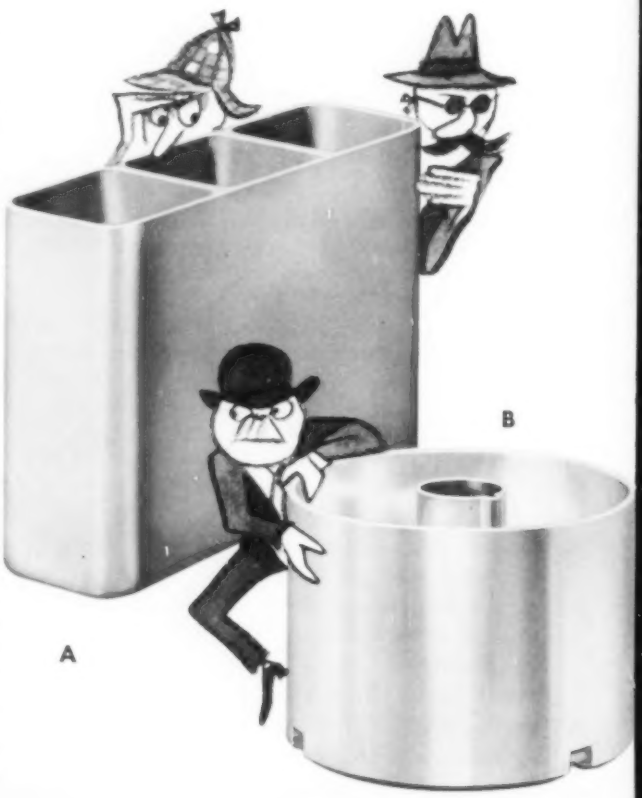
All of the foregoing should suggest to you that there is more than one way to bang out an impact. The best rule to follow is to suspect any closed-end tubular part or can-shaped part as susceptible to impact extrusion. And the best place to confirm those suspicions is at your local Alcoa sales office.

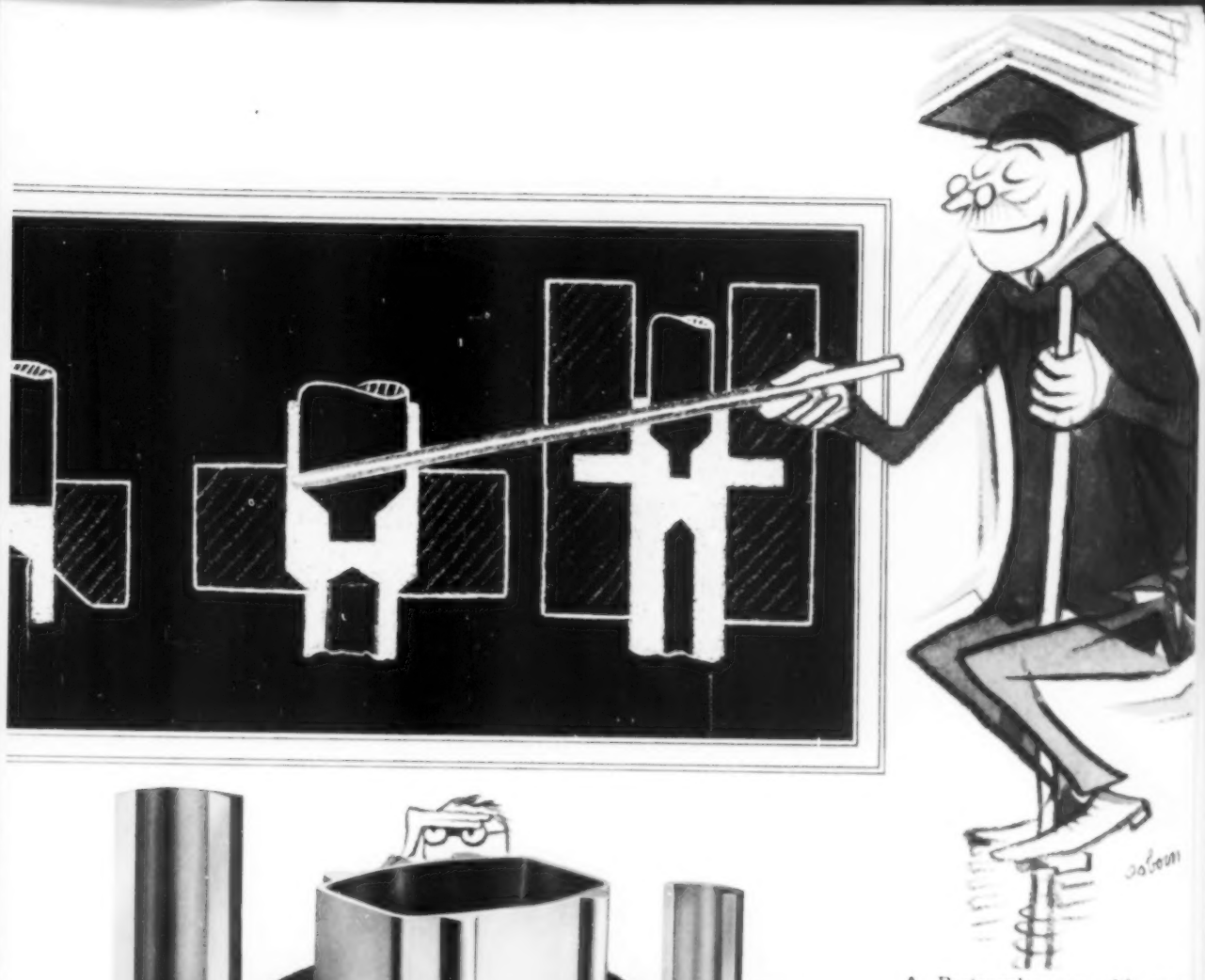


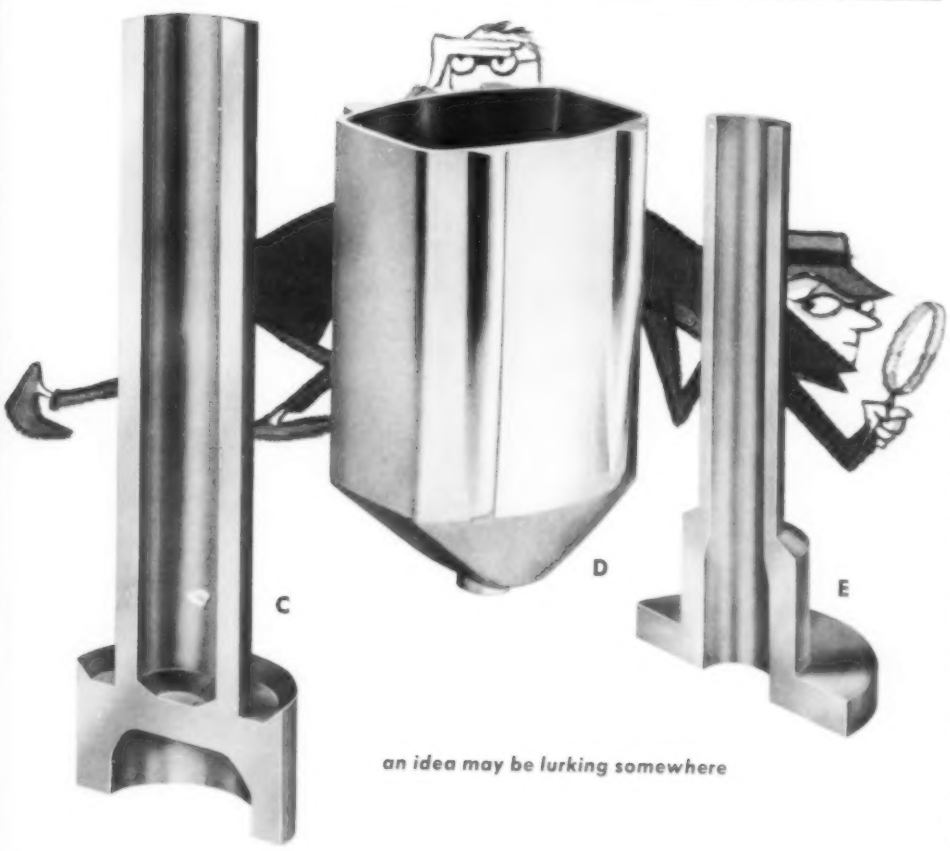
more than one way to bang out an impact

Some impossible jobs and a few difficult ones

Sounds like kidding, but many of the impacts you see across the bottom of these two pages would have made our production experts flip on edge ten years ago. Some still don't believe they are real. It's getting so that high-strength impacts of 7075 alloy and double-walled parts are downright commonplace. Asymmetrical parts are getting more common day by day. Forward-reverse combinations are old hat around our shop. More thinking is going into sideways impacts. Is all this well known among designers? On the chance that an idea may be lurking somewhere, check the five examples at the right.







an idea may be lurking somewhere

A—Rectangular can with two internal partition walls is a cost saver. Formed in one shot as an impact, it would be extremely costly in other methods of fabrication or assembly.

B—Center-tube shell with thin side walls and heavy base is one-piece, seamless impact. Groove in center tube and fastening notches in base are integral. Unit is produced quickly and inexpensively compared to machining or welding.

C—Machining time and metal scrap would be extremely high if this finished part (shown sliced) wasn't made as an impact.

D—Tapered ribs, tapered and internally double-shouldered base and outside boss are all made at once in this special shape impact extrusion. Formed with 0° draft in walls, it would be highly expensive in any other process.

E—Four thicknesses of wall and a midway flange make this newsworthy. It is an excellent idea-starter of the way Alcoa Impacts can solve difficult problems of fabrication. Let us try on your problem.

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Alcoa's Up-to-Dater on Impact Extrusions (continued)

is for alloy

In the alphabet of design, one of the first considerations is alloy selection. Designers have definite ideas about the tensiles and yields they need. They reconcile these requirements with the suitable types of fabrication available—and base their decision on the economies of the problem. In impacts, Alcoa offers six alloys with varying properties up to 75,000 psi tensile.

Naturally, the stronger alloy impacts cost more . . . but often they're worth it. Here is a quick run down arranged in ascending order of mechanical properties.

MINIMUM MECHANICAL PROPERTIES OF WROUGHT ALUMINUM ALLOYS COMMONLY USED IN ALCOA IMPACTS

ALLOY AND TEMPER	TENSION				HARDNESS①
	WALL THICKNESS	ULTIMATE STRENGTH LB/SQ IN.	YIELD STRENGTH (SET=0.2%) LB/SQ IN.	ELONGATION PER CENT IN 2" OR IN 4D	BRINELL 500-KG LOAD, 10-MM BALL
1100-H152②	All	18,000	.....	.....	...
1100-F③	.....	.....	.....	.....	...
3003-F③	.....	.....	.....	.....	...
6151-T6	All	44,000	37,000	7.0	90
6151-T84	.040"-.093" .094" & Heavier	35,000 38,000	32,000 35,000	4.0 4.0	80 80
6061-T4	All	26,000	16,000	12.0	50
6061-T6	All	38,000	35,000	7.0	80
6061-T84	.040"-.093" .094" & Heavier	35,000 38,000	30,000 35,000	4.0 4.0	75 75
2014-T4	All	55,000	32,000	10.0	100
2014-T6	All	65,000	55,000	7.0	125
7075-T6	All	75,000	65,000	7.0	135

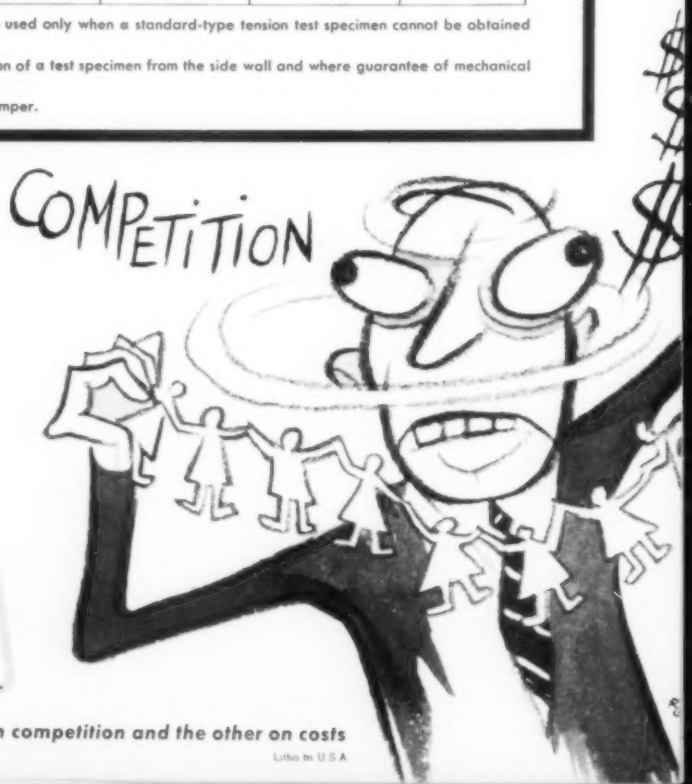
① Hardness test will be made only on the bottom of the part. It is used only when a standard-type tension test specimen cannot be obtained from the side wall.

② This temper designation applies only to parts that permit selection of a test specimen from the side wall and where guarantee of mechanical properties is required.

③ Mechanical property determinations are not required for this temper.

Straight Talk—Many a designer with one eye on competition and the other on costs has found a practical answer in Alcoa Impacts. Oftentimes the solid technical suggestion of an Alcoa sales engineer or a slight revision in an engineering drawing by one of Alcoa's Impact experts has made a mighty sales advantage. This kind of help is ready and waiting at your local Alcoa sales office. You'll find it listed under "Aluminum" in your classified phone book. Better still, write for Alcoa's new design handbook, *Alcoa Impacts:* 32 pages. ALUMINUM COMPANY OF AMERICA. 1994-H Alcoa Building, Pittsburgh 19, Pa.

Your Guide to the Best in Aluminum Value



one eye on competition and the other on costs

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Litho in U.S.A.

How gasket width affects the unit load required to maintain constant compression

An increase or decrease in gasket width does not always indicate that a change in the unit load is required to maintain constant compression. The type of gasket material used is the determining factor in most cases, as the examples below illustrate.

rubber gaskets

Since rubber is noncompressible, its load compression curve varies with the ratio of load area to free area. An increase in gasket width acts to impede sideflow, because it introduces additional material that must be displaced. To offset the added resistance, unit load must be raised to maintain constant compression. (It follows, of course, that the unit load must be reduced if the gasket width is decreased.) As shown in Figure 1, doubling the width of Armstrong DO-176—a

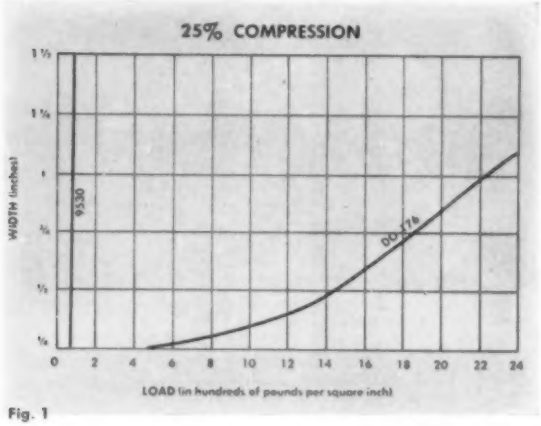

Fig. 1

straight rubber material—steps up the required unit load from 1400 psi for a ½-inch gasket to 2200 psi for a 1-inch gasket.

cork composition

Cork composition, on the other hand, is truly compressible. There is no problem of resistance to sideflow—because there is no sideflow. As shown in the curve for Armstrong 9530 Cork Composition (Figure 1), a unit load of 75 psi produces 25 percent compression regardless of gasket width.

cork-and-rubber

The properties of cork-and-rubber can be modified by combining the two materials in varying proportions. For example, Armstrong DC-167 Cork-and-Rubber material has a high cork content. Its behavior, therefore, approaches that of Armstrong 9530 Cork Composition. To maintain constant compression with DC-167, unit load increases only from 110 psi to 120 psi when gasket width is increased from ½ inch to 1 inch (Figure 2).

With Armstrong DC-113 Cork-and-Rubber, gasket behavior will be more rubber-like because of the material's relatively low cork content. Figure 2 shows that 660 psi are needed to produce 25 percent compression on a ½-inch gasket. When width is increased to 1 inch, a load of 780 psi is required. Other Armstrong cork-and-rubber compositions provide intermediate degrees of compressibility to meet particular requirements.

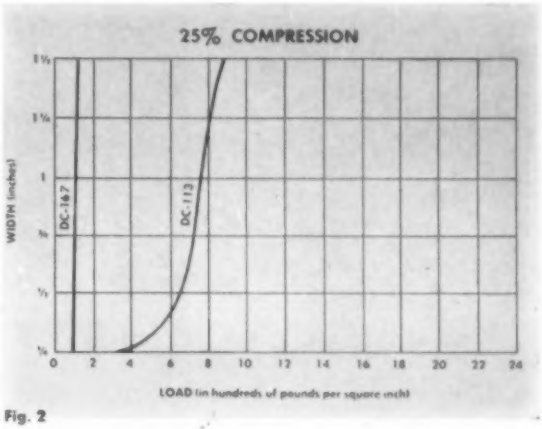

Fig. 2

The curves on this page illustrate why a compression specification should always state the sample gasket size, particularly with straight rubber compounds.

SEND FOR 24-PAGE GASKET MANUAL

You'll find other useful information on the design and use of gaskets in the new Armstrong Gasket Design Manual. Write for your copy to Armstrong Cork Company, Industrial Division, 7108 Irvin Street, Lancaster, Penna. For information on all Armstrong Gasket Materials, see Sweet's product design file.

Armstrong
GASKET MATERIALS
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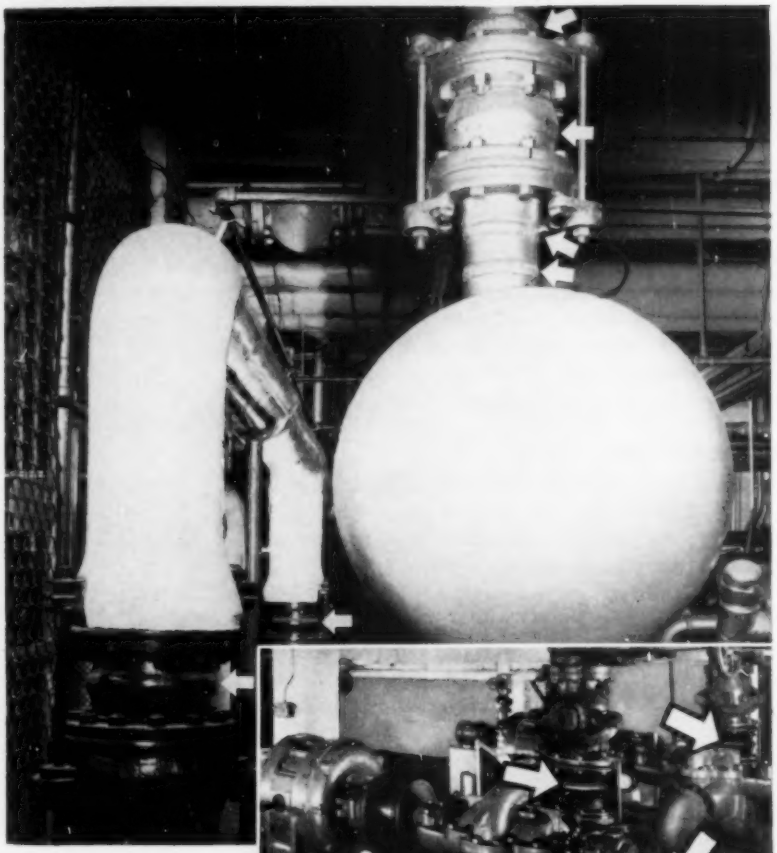
FOR SILENT, VIBRATION-FREE AIR-CONDITIONING SYSTEMS

Prevent transmission of compressor noises in circulating lines with U. S. Rubber Expansion Joints



A compressor with expansion joints on the suction and discharge lines. Suction line is at bottom, discharge line at top. Expansion joints were vulcanized to welded flanges at our factory, to handle Freon in the compressors.

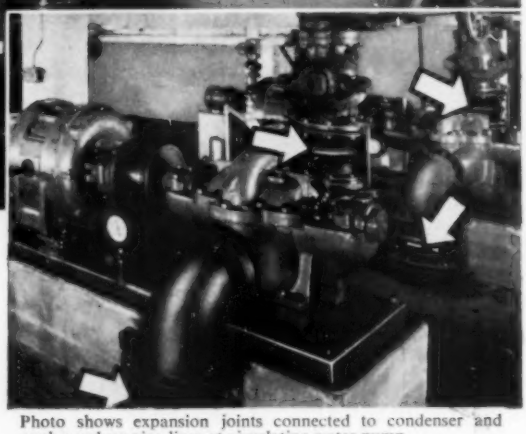


Photo shows expansion joints connected to condenser and cooler and on pipe lines at circulating water pump.

These flexible rubber connections for pressure and vacuum pipe lines insulate against vibration and prevent the transmission of noise. They also offset stresses caused by expansion and contraction and misalignment. You will find U. S. Expansion Joints are standard on many of the most up-to-date air-conditioning installations.

A product of United States Rubber Company, these U. S. Expansion Joints have many applications in air conditioning: they are used for the chilled-water lines from the water chillers, and the refrigerant lines from the refrigerating compressors; also the water lines to and from the cooling towers. They are used on the header connections to the condenser and to the cooler and on pipe lines at the circulating water pump.

For handling Freon in compressors, there is a specially-designed U. S. Freon Expansion Joint.

Since they have no moving parts to wear or bind, U. S. Expansion Joints last a long time. Some are still in service after 30 years—a record unmatched by any other expansion joint! U. S. Expansion Joints will solve any pipe line problem caused by noise, vibration and misalignment. They are obtainable at any of the 27 "U. S." District Sales Offices, or write us at Rockefeller Center, New York 20, N. Y.

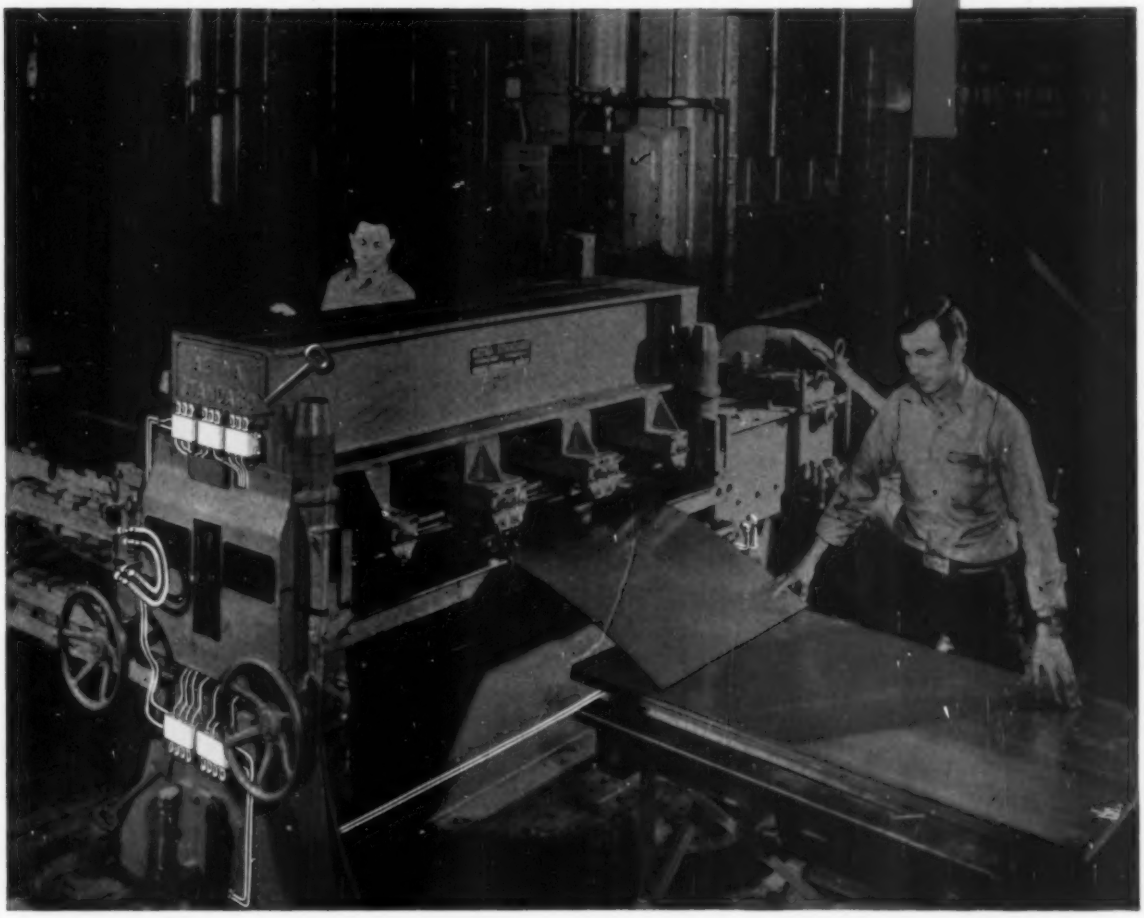
US RUBBER

Mechanical Goods Division

United States Rubber

Continuous, high-speed sheet levelling calls for continuous, precision lubrication

FARVAL—
Studies in Centralized Lubrication
No. 192



● Wherever high speed and heavy shock loads are involved, adequate lubrication of bearings is a must. It can't be a hit-and-miss proposition—there's too much at stake with costly machines and continuous production lines. The operation above is a good example. Here an Aetna-Standard sheet leveller flattens sheets at high speed. Failure or inaccuracy interferes with succeeding forming and stamping operations. With Farval on guard, such eventuality will not occur.

Farval delivers a measured amount of clean lubricant to every bearing at regular intervals. No bearings are ever missed—and the amount delivered to any bearing can be varied without affecting the rest of the system. Farval saves production hours, maintenance, labor.

Ask, now, for a free lubrication survey. Let us send one of our lubrication engineers to inspect your plant equipment. Without obligation, he will present a written analysis of what Farval can do for you. Write the Farval Corporation, 3279 E. 80th St., Cleveland 4, O.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.

KEYS TO ADEQUATE LUBRICATION—
Wherever you can see these Farval manifolds, dual lubricant lines and central pumping station, you know a machine is being properly lubricated.

Here, Farval serves an Aetna-Standard leveller in an Ohio metalworking plant.

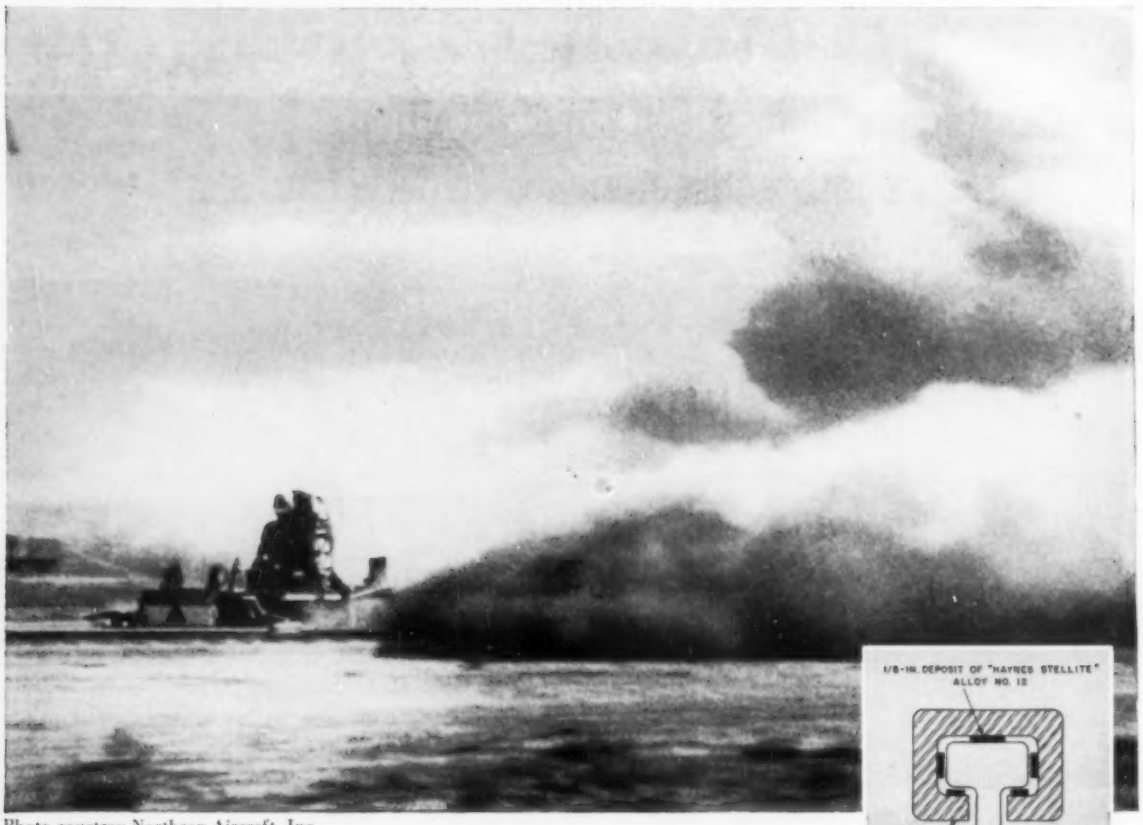


Photo courtesy Northrop Aircraft, Inc.

Rocket Sled Rides at Supersonic Speeds on Hard-Faced Slippers

Four hard-faced slippers bear the entire weight of this rocket-propelled sled as it hurtles down a special railway at more than 900 miles per hour. Hard-facing protects the slippers from abrasion and the tremendous frictional heat generated during each run, and enables them to make 12 trips. Before hard-facing was adopted, the slippers wore rapidly and often had to be replaced after every trip.

As the sketch (above) shows, each slipper is hard-faced at five locations with HAYNES STELLITE alloy No. 12 rod. The cobalt-base alloy is deposited by the metallic-arc method and then finished by machining.

The successful use of HAYNES STELLITE rod on the rocket sled slippers emphasizes several outstanding characteristics of this cobalt-base material. It has exceptional resistance to metal-to-metal wear and frictional heat. It retains its hardness even when exposed to temperatures in the red heat range. In addition, it will withstand the effects of corrosion, erosion, and oxidation, and it has a low coefficient of friction. This combination of properties makes it extremely valuable for protecting such industrial parts as valves, valve seats, bushings, pump shaft sleeves, mandrels, extrusion screws, punches, and dies.

For full information on the complete line of 19 HAYNES hard-facing alloys, designed for every condition of wear, write for the booklet, "HAYNES Alloys Hard-Facing Manual."

HAYNES TRADE-MARK ALLOYS

HAYNES STELLITE COMPANY

A Division of Union Carbide and Carbon Corporation

UCC

General Offices and Works: Kokomo, Indiana

Sales Offices

Chicago • Cleveland • Detroit • Houston • Los Angeles • New York • San Francisco • Tulsa

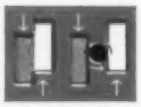
"Haynes" and "Haynes Stellite" are registered trade-marks of Union Carbide and Carbon Corporation.

SAGINAW b/b SCREWS are guaranteed 90% EFFICIENT!

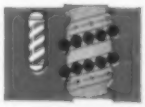
Require 2/3 LESS torque than Acme Screws for same linear output on Actuator and Positioner Applications! Saves space, weight!

ORIGINAL DESIGNERS AND PRODUCERS OF MULTIPLE CIRCUITS
If one circuit should fail, the rest will function without interruption, sharing the load between them. In critical applications this feature has no equal.

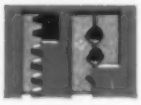
WHAT IT IS AND HOW IT WORKS



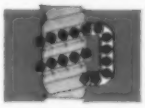
Let's start at the beginning, with the familiar principle that there's far less friction in *rolling* than in *sliding*. By applying this principle,



Like stripes on a barber pole, the balls travel toward end of nut through spiral "tunnel" formed by concave threads in both screw and mating nut.



the *Saginaw ball/bearing Screw* radically increases the efficiency of rotary-to-linear motion (and vice versa). Instead of *sliding*, mating surfaces *glide* on rolling steel balls.



At end of trip, one or more tubular guides lead balls diagonally back across outside of nut to starting point, forming closed circuit through which balls recirculate.

DESIGN ADVANTAGES

1. Increases efficiency — Acme screw is 15%-20% efficient — b/b screws are 90%-95% efficient.

2. Saves power — requires 2/3 less torque than Acme screws for same linear output.

3. Saves space — permits smaller motors, gear boxes; eliminates pumps, piping, accumulators.

4. Assures positive positioning — permits precision control within thousandths of an inch.

SAGINAW b/b SPLINE

Utilizing the same basic *gliding ball* principle, Saginaw has developed the *Saginaw b/b Spline* which radically increases the efficiency of transmitting or restraining high torque loads.

Averages 40 times lower friction coefficient than sliding splines!

It can be fitted with integral gears, clutch dogs, bearing and sprocket seats, etc., for use with a wide variety of electrical units. AVAILABLE IN ALMOST ANY SIZE. (Units have been engineered as small as $\frac{3}{8}$ IN. IN DIAMETER.)

Saginaw ball/bearing Screws & Splines

SAGINAW STEERING GEAR DIV., GENERAL MOTORS CORP., SAGINAW, MICH.

SEND COUPON FOR 32-PAGE ENGINEERING DATA BOOK

Saginaw Steering Gear Division, General Motors Corporation
b/b Screw and Spline Operation
Dept. 9J, Saginaw, Michigan

Please send new engineering data book on Saginaw b/b Screws and Splines to:

NAME _____

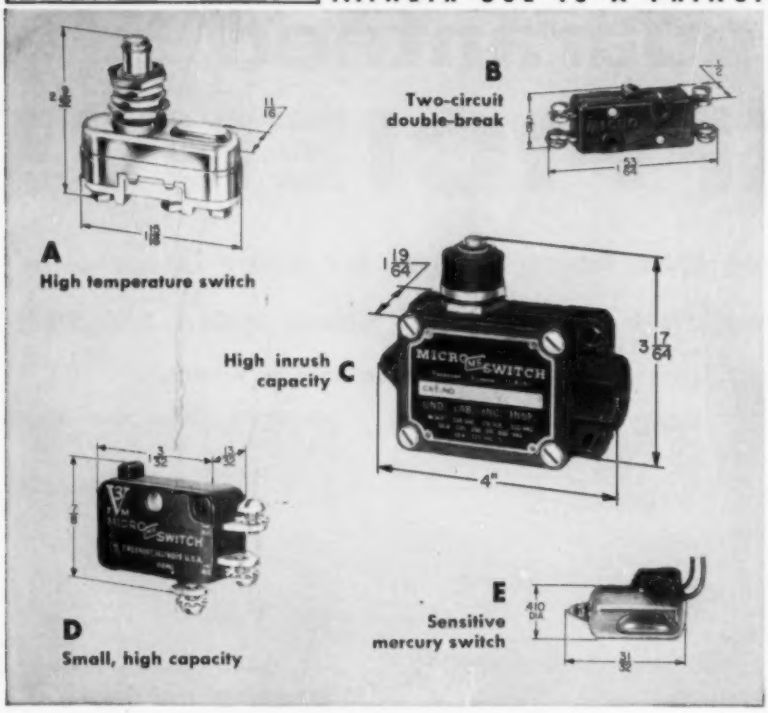
COMPANY _____ TITLE _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

MICRO *precision switches*

...THEIR USE IS A PRINCIPLE OF GOOD DESIGN



A continuous flow of Precision Switch developments anticipates designers' needs

Whatever your requirements for an extremely reliable precision switch, there is—or can be—a MICRO SWITCH product to meet it. It makes no difference whether your switch must control sensitive electronic devices, instruments or heavy automatic machinery. Experienced designers save time and money by checking with MICRO SWITCH—pioneer manufacturer of precision switches.

Illustrated are a few examples of the wide range of MICRO SWITCH units to meet design requirements. These include hermetically sealed switches, switches for control of multiple circuits, switches resistant to high temperatures, heavy duty switches with high electrical capacity and very small switches—all for extremely precise operation.

A·High temperature switch. This switch will operate satisfactorily in a temperature range of from —50° F to plus 1000° F. Originally designed for use in jet aircraft applications, on or near the after-burner, the switch is equally useful for industrial applications which require high temperature components.

B·Two-circuit double-break switch fills the need for a small, two-circuit double-break switch for controlling two isolated circuits. This allows greater flexibility and simplicity of circuit design. A snap-action spring provides quick make and break of both circuits in each double-break circuit.

C·High capacity, sealed plunger switch. Compact, easy to mount precision snap-action switch which combines long life and reliability with the capacity to make and break steady state currents of 20 amperes and to handle inrush currents as high as 75 amperes.

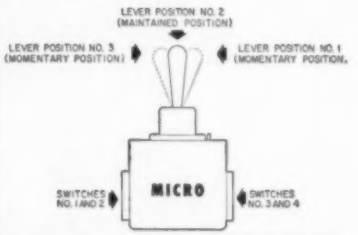
D·V3 small, high-capacity switch: MICRO V3 switches have extremely high electrical capacity for their size. They were developed to meet exacting design requirements for an extremely small switch with no sacrifice of quality. V3 switches are available with a wide variety of circuit arrangements, operating characteristics and actuators.

E·Sensitive mercury switch with ¼° operating angle. Small Honeywell Mercury Switches are designed to meet the demand of small load circuits and applications where space and economy are critical factors. Ratings may often be extended successfully down to microvolt milli-ampere ranges.

NEW!

An "Electrical Memory" Toggle Switch

Here is the first in a new series of "electrical memory" toggle switches. It is a four-pole assembly with one pole to indicate which circuit was last operated. It promises to simplify and perhaps revolutionize some basic circuit designs of complicated ground radar units, computer devices, aircraft control panels and other types of remote control equipment.


LEVER POSITION NO. 2 (MAINTAINED POSITION)
LEVER POSITION NO. 3 (MOMENTARY POSITION)
LEVER POSITION NO. 1 (MOMENTARY POSITION)
MICRO
SWITCHES NO. 1 AND 2
SWITCHES NO. 3 AND 4

	Lever Position No. 1	Lever Position No. 2	Lever Position No. 3
Switch No. 1	N.O. To C. Circuit Made	N.C. To C. Circuit Made	N.C. To C. Circuit Made
Switch No. 2	N.O. To C. Circuit Made	N.C. To C. Circuit Made	N.C. To C. Circuit Made
Switch No. 3	N.C. To C. Circuit Made	N.C. To C. Circuit Made	N.O. To C. Circuit Made
Switch No. 4	N.C. To C. Circuit Made	*	N.O. To C. Circuit Made

*N.C. To C. Circuit Made if Lever Last Moved To Lever Position No. 1
*N.O. To C. Circuit Made if Lever Last Moved To Lever Position No. 3

The assembly uses three single-pole, double-throw functional basic switches and one single-pole, double-throw "memory" switch.

In application the "memory" switch indicates through a pilot light or buzzer which circuit was last operated.

The three functional switches operate at three lever positions: maintained center and momentary from each extreme position.

Electrical rating of basic switches: 5 amperes 125 or 250 volts a-c. The d-c rating at 30 volts: inductive—3 amperes at sea level and 2.5 amperes at 50,000 ft.; resistive—4 amperes at sea level and 4 amperes at 50,000 feet; maximum inrush—15 amperes.

For complete information on any of these switches or the complete MICRO SWITCH *line, call the* MICRO SWITCH *branch near you.*

MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

In Canada, Leaside, Toronto 17, Ontario • FREEPORT, ILLINOIS

New heavy-duty precision lathe mounts spindle on TIMKEN® bearings for maximum rigidity thru 12-speed range

THE new Atlas-Clausing 5300 has new massive headstock and tailstock, heavy-duty bed and carriage for rigidity and stamina. The spindle bearings must have high precision, must maintain that precision at all speeds, under heavy loads. That's why Atlas-Clausing chooses Timken® precision bearings.

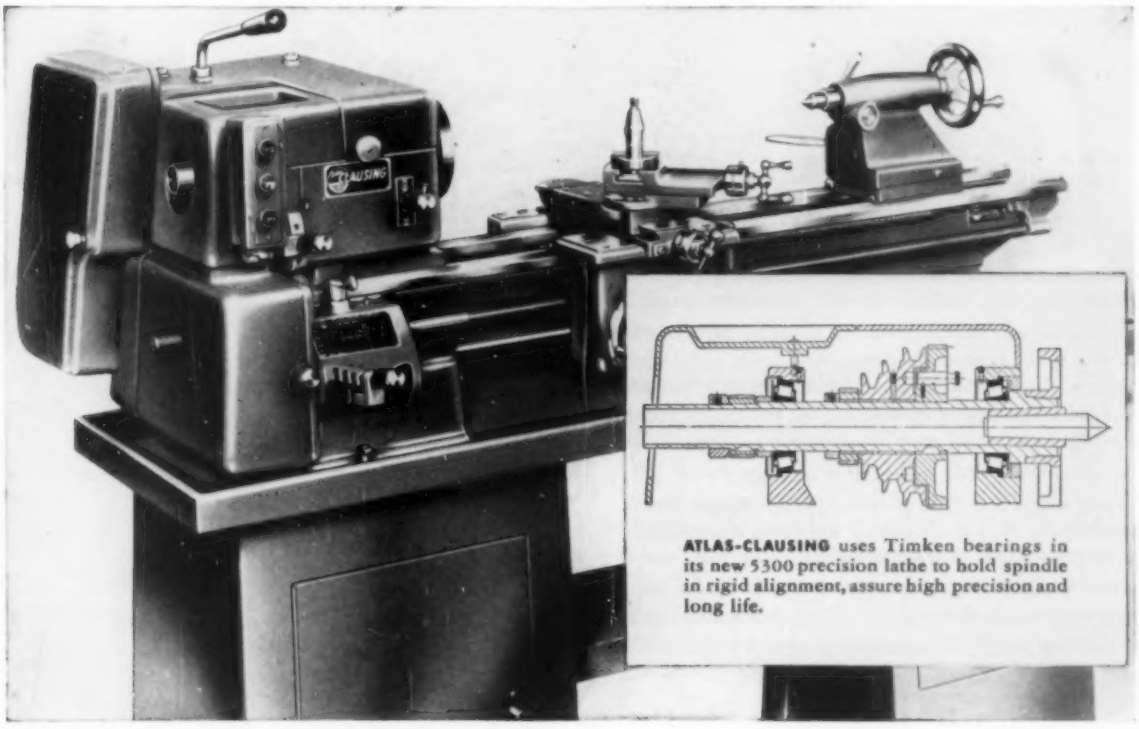
Timken bearings, because of their tapered design, take radial and thrust loads in any combination, hold spindle in rigid alignment. There is no end play. Timken bearings assure precision at all times.

The extra load-carrying capacity of Timken bearings comes from the full line contact between the rollers and races. And, since Timken bearings are built to last the life of the lathe itself, maintenance costs go down.

Timken bearings save power because they practically eliminate friction. They are geometrically designed to give true rolling motion, precision manufactured to live up to their design. And to make sure we get steel good enough for Timken bearings, we make it ourselves. No other U. S. bearing maker takes this extra step to insure quality in every bearing.

You can get all the advantages of Timken bearings only by specifying Timken bearings in all the equipment you build or buy. Look for the "TIMKEN" trade-mark on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



ATLAS-CLAUSING uses Timken bearings in its new 5300 precision lathe to hold spindle in rigid alignment, assure high precision and long life.

IT'S TIMKEN BEARINGS FOR VALUE!

To get the best value in bearings you may find this simple formula helpful:

$$Value = \frac{quality + service + public\ acceptance}{price}$$

Obviously a big advantage *above* the line gives you more value than a small one *below*. No other bearing can match the uniform high quality, engineering and field service and overwhelming public acceptance you get with Timken bearings.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ⟊ AND THRUST ⟊ LOADS OR ANY COMBINATION ✳

A new Dayton V-Belt gives Quiet, Vibrationless, Dustless power transmission on light-duty drives

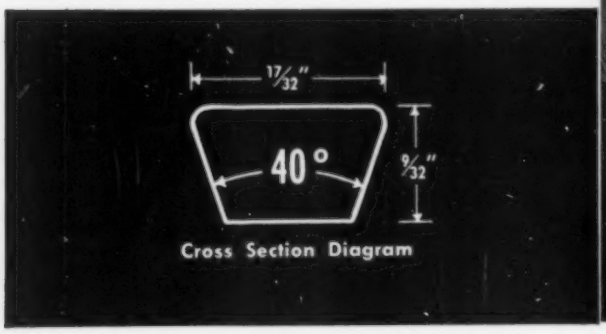
In the design of fractional horsepower V-Belt Drives where it is necessary or advantageous to minimize noise, reduce vibration and prevent dusting, the new Dayton QVD Belt should be specified.

Dayton QVD Belts are already in successful use on such light-duty drives as fans, blowers, air conditioners, household appliances and home workshop tools. These special duty V-Belts are now available in full production quantities.

Designed and precision-built of SPECIAL MATERIALS, Dayton QVD Belts are manufactured under strict quality controls. Each V-Belt is electronically checked for quietness and smoothness of operation. Thus you are assured that every QVD Belt will meet your drive requirements.

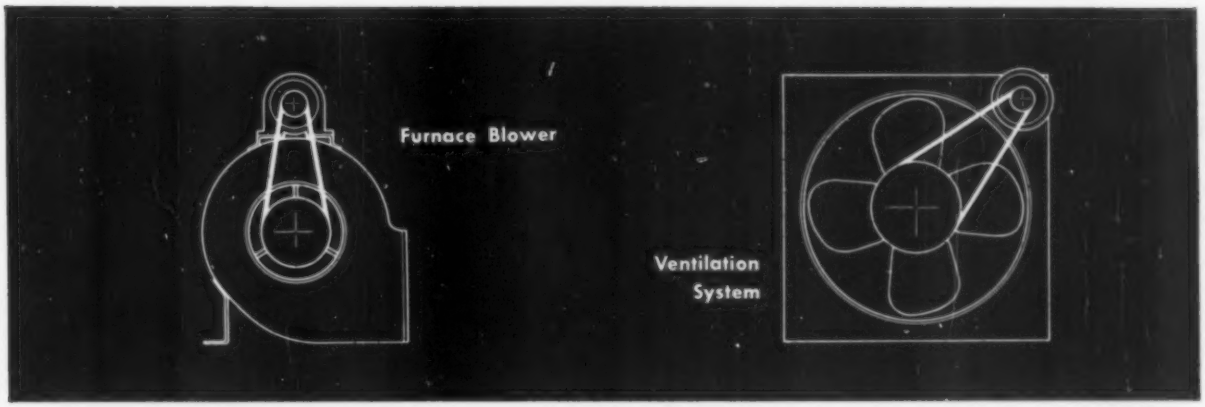
Dayton QVD Belts are available in lengths from 31″ to 51″ in the $^{17}/_{32}$″ cross section. Special sizes in Dayton's standard 3L, 4L and 5L FHP V-Belts can be produced in QVD construction on quantity orders.

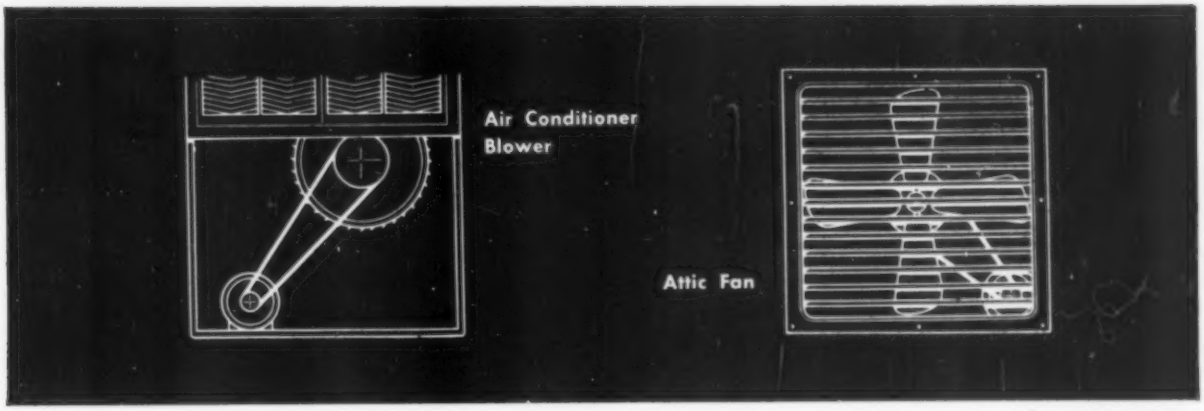
Dayton QVD Belts are designed specifically for use on light-duty drives where Quiet, Vibrationless and Dustless operation is of PRIME importance.



Cross Section Diagram

Dayton's exclusive Vibration Analyzer measures vibration amplitude and frequency of each V-Belt against pre-set allowable limits, then signals "Accept" or "Reject" to the operator.





Special Dayton QVD Belt construction features make it ideal for use on fan, blower and air conditioner drives.

Quiet-running Dayton QVD Belts are precision-built and balanced. Special cords in the strength section give each V-Belt a BUILT-IN elasticity, minimizing noise from over-tensioning and load impulses. Uniform impregnation of the fabric covers with special rubber compounds eliminates annoying squeaking and chirping sounds.

Dustless performance, of utmost importance in blower drives, is assured with Dayton QVD Belts. Specially compounded and processed rubber is used in the fabric cover . . . rubber which will not wear off to become a fine, black powder. Thus there is nothing for the swiftly moving air of ventilation systems to circulate through homes and offices.

You can obtain further information about the Quiet, Vibrationless, Dustless performance of Dayton QVD Belts by contacting your Dayton Representative, or write The Dayton Rubber Co., Industrial O.E.M. Div., Dayton 1, Ohio.

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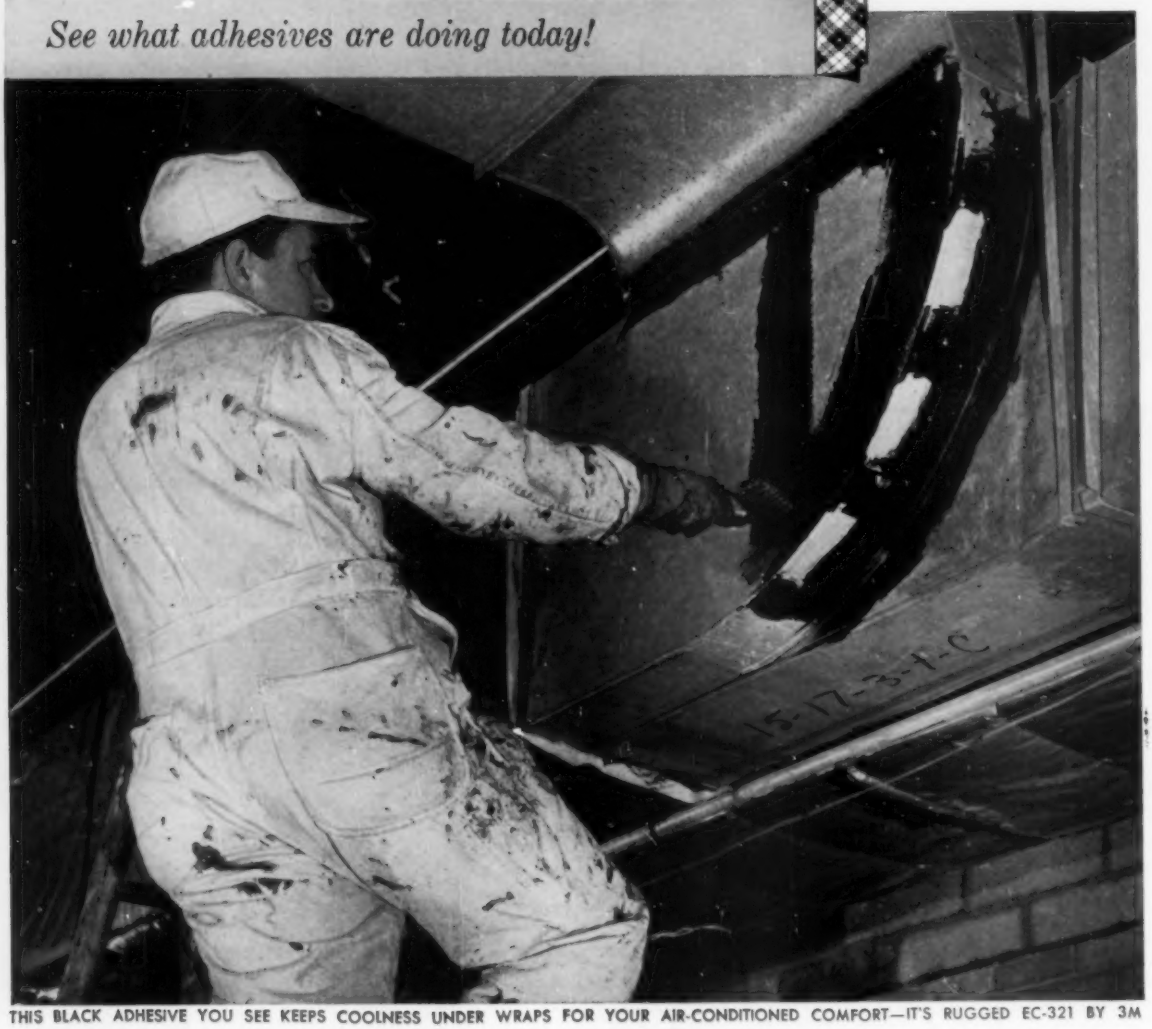
Dayton Rubber

51 YEARS OF PROGRESS

WORLD'S LARGEST MANUFACTURER OF V-BELTS

See what adhesives are doing today!



THIS BLACK ADHESIVE YOU SEE KEEPS COOLNESS UNDER WRAPS FOR YOUR AIR-CONDITIONED COMFORT—IT'S RUGGED EC-321 BY 3M

Holding a grip on sweating metal

You can feel the cold metal "sweating" as moisture condenses on it. Yet, to provide air-conditioning efficiency, you must apply insulation to the surface of this duct. And you have to do it despite condensation.

EC-321 holds insulation tight regardless of that moisture. The architect here specified this 3M adhesive after he saw a competitive adhesive fail. It was literally "sweated" loose.

EC-321 brushes easily, grips at once and allows enough working time. Where the fibrous glass must be drawn up between ducts, EC-321 doesn't bind or tear. It's nonflammable, fastens liner to duct interiors, bonds insulation to hot-air ducts, too.

Hundreds of 3M adhesives serve many varied metalworking industries, all the way from factory to installation.

SEE WHAT ADHESIVES CAN DO FOR YOU! If you face a fastening problem, call your 3M Field Engineer. Consult 3M research. For a free booklet write: 3M, Dept. 48, 417 Piquette Ave., Detroit 2, Mich.

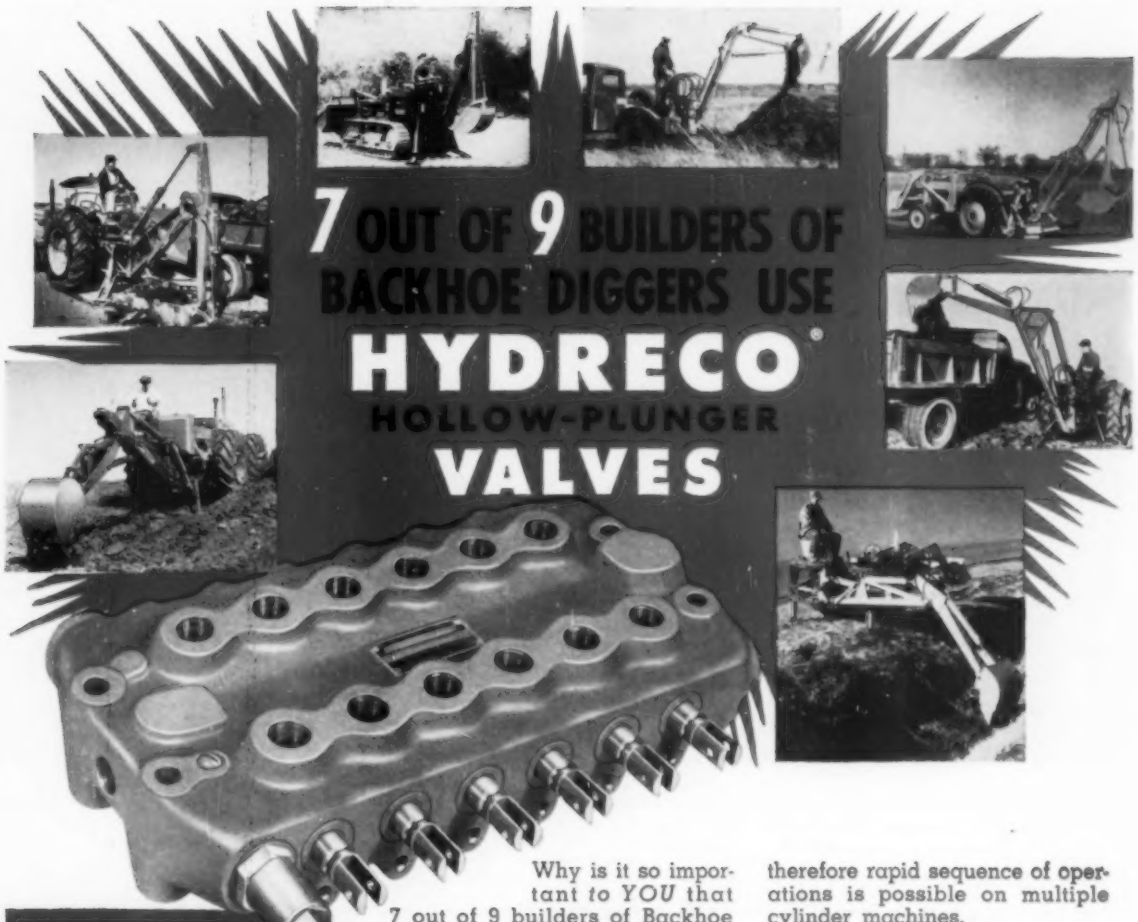
PRODUCT OF 3M RESEARCH

3M ADHESIVES

ADHESIVES AND COATINGS DIVISION, **MINNESOTA MINING AND MANUFACTURING COMPANY**

417 PIQUETTE AVE., DETROIT 2, MICH. • GENERAL SALES OFFICES: ST. PAUL 6, MINN. • EXPORT: 99 PARK AVE., N. Y. 16, N. Y. • CANADA: P.O. BOX 757, LONDON, ONT.

MAKERS OF "SCOTCH" BRAND PRESSURE-SENSITIVE ADHESIVE TAPES • "SCOTCH" BRAND SOUND-RECORDING TAPE • "SCOTCHLITE" BRAND REFLECTIVE SHEETINGS • "3M" ABRASIVE PAPER AND CLOTH • "3M" ADHESIVES AND COATINGS • "3M" ROOFING GRANULES • "3M" CHEMICALS



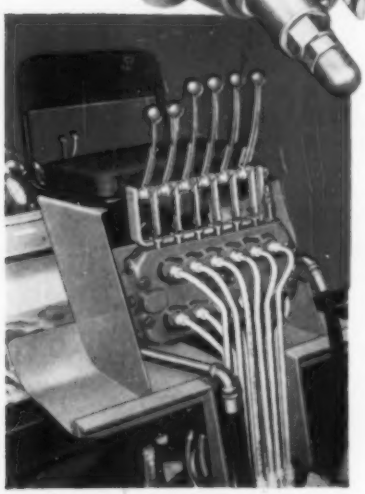
7 OUT OF 9 BUILDERS OF BACKHOE DIGGERS USE HYDRECO® HOLLOW-PLUNGER VALVES

Why is it so important *to YOU* that 7 out of 9 builders of Backhoe Diggers use HYDRECO Hollow-Plunger Control Valves? Analyze the functions involved in this Fluid Power application, and the answer is clear. Here is a rugged service application requiring multiple manual control of Fluid Power operations, good throttling, and easy-to-reach controls. All these features are combined in Hydreco Hollow-Plunger Valves to give the operator a feeling of "playing" the machine.

Hydreco Hollow-Plunger valves are perfect for this application. Check valves built into the plungers absolutely prevent back flow and cross flow between cylinders, therefore rapid sequence of operations is possible on multiple cylinder machines.

The Hydreco valve enables the operator to level, dig, hoist, swing and dump quickly and easily. The operator has the touch he needs to get the best out of a good machine, day in and day out. That's why operators like Hydreco Hollow-Plunger Valves.

Designers like Hydreco valves too, because with all components built in, they come smaller and fit into tight places more easily. For smoother operation, for more work at less cost — apply HYDRECO Hollow-Plunger Valves to your multiple-function equipment!



Hydreco valves are available with up to 6 plungers.

Member NFPA

KALAMAZOO DIVISION
THE NEW YORK AIR BRAKE COMPANY

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INTERNATIONAL SALES OFFICE, 90 WEST ST., NEW YORK 6, N. Y.

Kalamazoo Division
The New York Air Brake Company
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Kalamazoo, Michigan

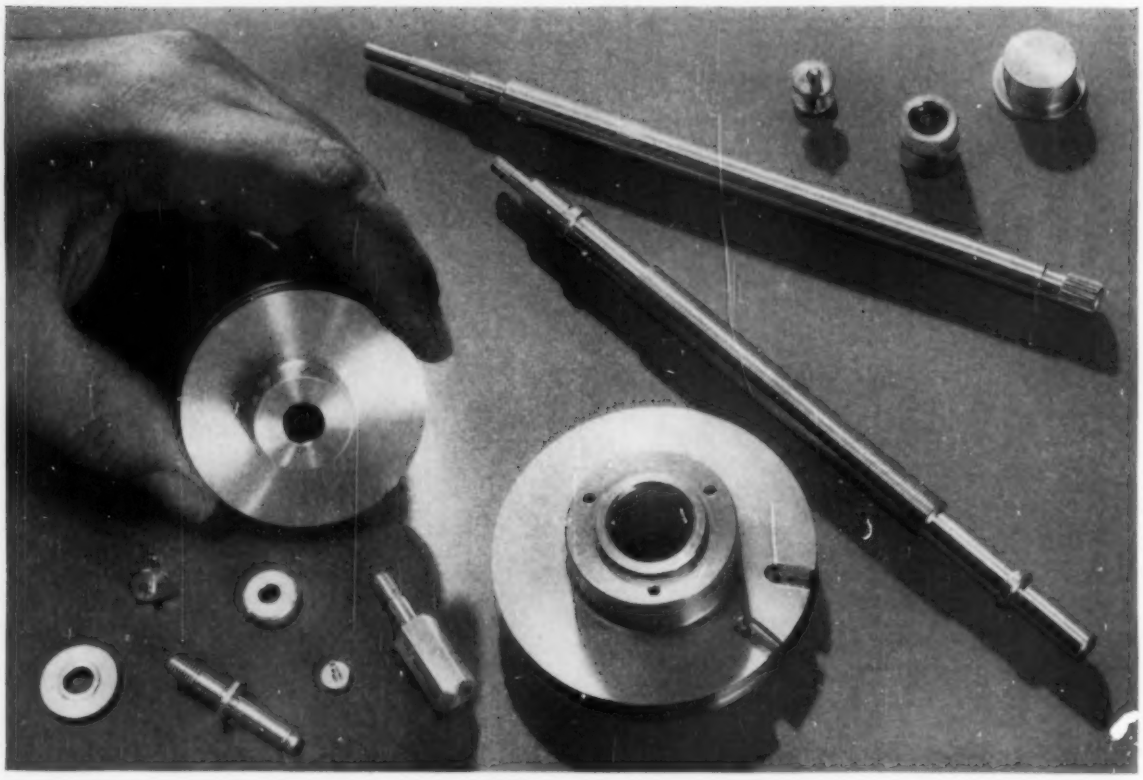
Kindly send me full information on Hydreco Hollow-Plunger Control Valves.

Name_____

Company_____

Address_____

City_____ Zone____ State_____



TYPICAL PARTS made of Alcoa Aluminum Screw Machine Stock at Dictaphone Corporation include long, slender feed screws that used to present threading problems in steel. Tolerances of three tenths are not unusual. High stock removal is routine with aluminum.

HOW DICTAPHONE CORPORATION* DESIGNS FOR SALES WITH ALCOA ALUMINUM SCREW MACHINE STOCK

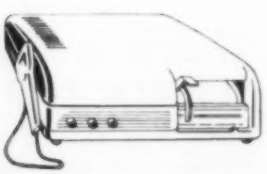
The day the dictating machine left the office and started traveling with the salesmen, surprising things happened. At Dictaphone Corporation, for example, their famous Time-Master dictating machine went on a reducing diet. From 20 pounds, this versatile machine shrank to 12.4 pounds. Aluminum screw machine parts played a major role in making the Time-Master light and portable. But, most important are the other advantages that came to Dictaphone with their switch to Alcoa® Aluminum. "Problem parts" in stainless and mild steel suddenly became routine when Alcoa Aluminum Screw Machine Stock was used. Tool and wheel life increased. Rust problems ended.

While weight reduction may not be the primary consideration for your product, the economic savings and many added advantages of aluminum can solve other problems. Low material costs (three times as many pieces from each pound), excellent machinability, ease of finishing and high resistance to corrosion will make Alcoa Aluminum Screw Machine Stock your choice for non-rusting parts. If you need high heat or electrical conductivity, aluminum has these, too.

These facts practically dictate a hard look at aluminum for the majority of your screw machine parts. To help you take that look, qualified screw machine experts are available at your local Alcoa sales office listed under "Aluminum" in your classified phone book. Aluminum Company of America, 865-H Alcoa Bldg., Pittsburgh 19, Pa.

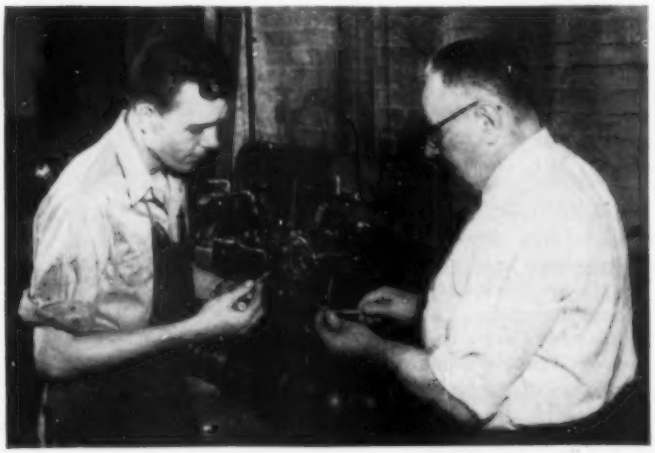
*

Dictaphone
CORPORATION



Mr. J. S. Decker, Mr. E. J. Kwantz and Mr. J. S. Kemp (left to right) discuss purchase of materials for Dictaphone's new Time-Master.

Mr. T. Chanoux (standing) talks over the design of a Time-Master part with Mr. W. G. Deschenaux.



On-the-job production conference between Mr. S. J. Redmond and Mr. J. A. Gunger.

IN PURCHASING

Mr. E. J. Kwantz, Buyer, says, "One reason we do business with Alcoa is because they study our problems and make helpful suggestions. In cases of extremely tough delivery requirements, Alcoa expedites quickly from their mills and warehouses. Availability and quality are big advantages in buying from Alcoa. We find scrap disposal easier with aluminum than with steel."

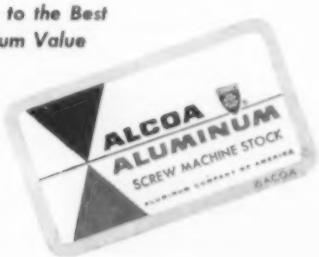
IN DESIGN

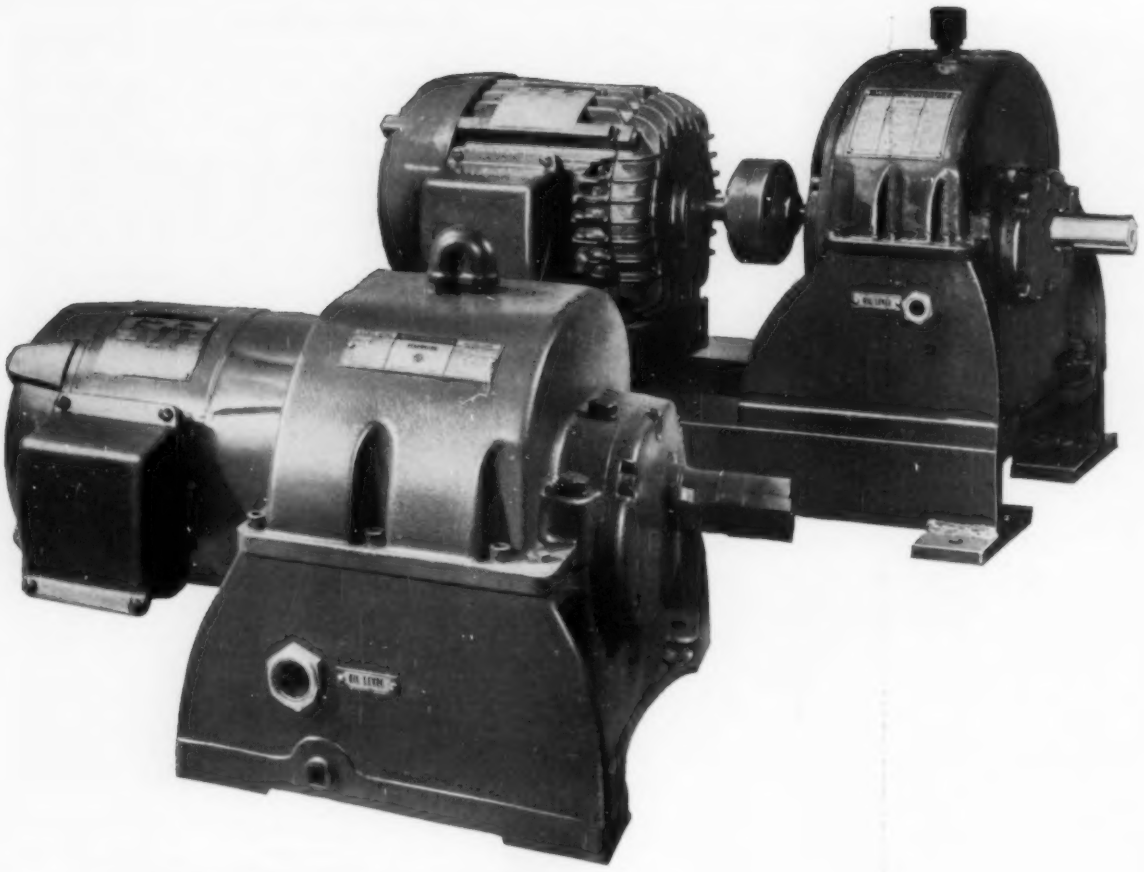
Mr. Theodore Chanoux, Chief Production Engineer, says, "Five years ago we would have been astounded at what we are doing with aluminum today. In addition to weight savings, aluminum screw machine stock helps us solve other design problems. Acme threads were impossible in stainless parts; they're simple with aluminum. Where we have to specify plating or other special finishes for ferrous parts, simple anodizing of aluminum saves us money. Some of our machined parts are bearing surfaces. Here, too, aluminum performs well."

IN PRODUCTION

Mr. Matthew Luciani, General Foreman, says, "We can chase an Acme thread on aluminum with two passes compared to six or seven with stainless steel. Tool and wheel life is longer. Lubricants used with aluminum don't get rancid and smelly. Our operators like this, and they like the fact that aluminum chips don't cut them. We make about 80 aluminum parts for the Time-Master at tremendous production savings. We run machines at top speeds and feeds. The parts don't rust in storage."

Your Guide to the Best in Aluminum Value





GEARMOTOR OR PACKAGED DRIVE?

Your selection has a longer future with Westinghouse BPT gearing

Westinghouse gearmotors and DB packaged drives offer important advantages to simplify drive problems and provide long-range dependability.

First, you'll find both lines of gearing readily available. They provide a wide selection in horsepower, speed ratios, direction of power take-off, mounting and coupling methods. This sort of flexibility is bound to save you time in answering space and load problems.

Second, Westinghouse BPT gearing, in both lines, assures a long-range solution to any drive problem. The exclusive BPT heat-treatment process produces unmatched, long wearing, shock-resistant qualities as a result of taper hardening each gear tooth. Heavy-duty, antifriction bearings also insure continued high efficiency under changing load demands.

Get all the facts on Westinghouse gearmotors and DB packaged drives today from your local Westinghouse salesman; or write Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pennsylvania.

J-07351

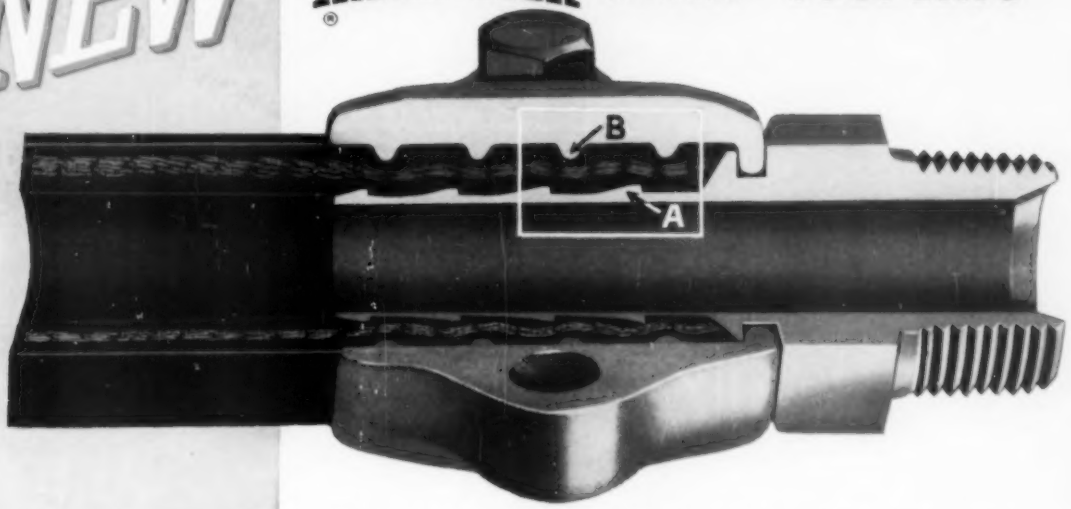
Exclusive BPT heat-treatment produces a taper hardness from surface to core of each gear tooth for toughness and hardness.

WATCH WESTINGHOUSE!

*WHERE **BIG** THINGS ARE HAPPENING **TODAY!***

NEW Eastman

INTER-LOCK® CLAMP COUPLING



EASTMAN MFG. CO. announces its New **Inter-Lock** Clamp Coupling—offering *exclusive grip advantages* available in no other coupling of its type.

EXCLUSIVE EASTMAN INTER-LOCK FEATURES

Eastman's New **Inter-Lock** Clamp Coupling provides positive positioning through accurate machining of clamp and insert—as the outside rib of the clamp is locked between the collar and hex of the insert, before tightening.

The accurate location of the clamp over the insert assures alternate mating of the barbs of the insert (A) with the circular ribs of the clamp (B).

Hose is uniformly compressed into each alternating recess—increasing the holding power of the Clamp Coupling—thereby creating **Eastman's Exclusive Inter-Lock Grip.**

Longer service is assured because hose construction is not weakened by pinching, as it may be if ribs and barbs were permitted to fall directly opposite each other.

EASTMAN'S Exclusive **Inter-Lock** feature is another example of advanced design and engineering which gives you greater value, plus the *all-important competitive advantage* of superior product performance and customer satisfaction in the field.

Look to EASTMAN . . . *first in the field* of Hydraulic Hose Assemblies . . . for continued leadership in design and engineering—plus the highest quality material and workmanship.

STANDARD INSERTS FOR EASTMAN INTER-LOCK CLAMP COUPLING

For low, medium and high pressure hose up to 5000 psi. working pressure. Available for hose sizes ranging from ¼" to 2" I.D.—according to pressure requirements. Also available for angle and straight tube applications.

SWIVEL FEMALE

MALE PIPE

MALE FLARE

INSERT FEATURE
Beveled shoulders of barbs permit easy insertion into hose.

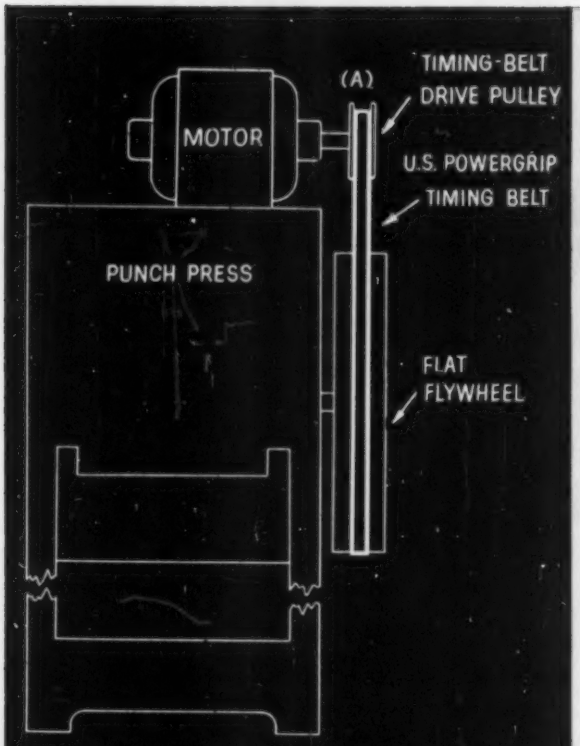
WRITE for Standard Sizes or send your blueprints and specifications.

SAFEGUARDING INDUSTRY'S *Lifeline of Mobile Power*

Eastman *first in the field*

MANUFACTURING COMPANY
Dept. PE-8, Manitowoc, Wis.

PowerGrip "Timing" Belts



To eliminate severe belt slippage and consequent burning of belt (at point A) when 5 h.p. motor was started, the conventional pulley and belt drive from the motor shaft were replaced with a grooved pulley and a U.S. PowerGrip "Timing" Belt driving the flat flywheel. The positive engagement of the "Timing" Belt eliminated slippage on the motor pulley completely. The slight remaining slippage is now dissipated over the much greater area of the flywheel. Result: Flywheel gets up to speed *without burning the belt*, thereby reducing maintenance and downtime costs.

How a plant engineer made this press deliver a better punch

This is one more example of the U.S. PowerGrip "Timing"® Belt's ability to simplify and improve a power transmission unit . . . one of the reasons why the invention of this belt was recently awarded the Franklin Institute's Edward Longstreth Medal for "Invention of High Order."

Whether it's a plant conversion or original equipment design problem, U.S. PowerGrip "Timing" Belts offer the plant and design engineer all these advantages:

- *no slippage, no take-up—allows short centers, high ratios.*
- *absence of metal-to-metal contact—eliminates need for lubrication and housing devices.*
- *handles speeds up to 16,000 F.P.M. or so slow as to be imperceptible to the eye.*
- *close to 100% efficiency.*
- *imbedded with steel cables for high tensile strength.*
- *constant angular velocity.*

These belts—plus expert engineering service—are obtainable at "U.S." power transmission distributors, at any of the 28 "U.S." District Offices, or by writing us at Rockefeller Center, New York 20, N. Y.

Mechanical Goods Division

United States Rubber

Pushed for Greater Drafting Room Output?
Modern Reproduction Machines Will Help You Get It!

NOW Is the Time to Get Your New, Modern BRUNING COPYFLEX MACHINE!

The boom in production means more pressure than ever for engineering drawings and prints. Right now is the time to replace that old inadequate reproduction machine you've been putting up with — now's the time to get a modern, efficient Bruning Copyflex.

In just the last year, Bruning has introduced five new, advanced machine models, one of which is shown at the right. These machines offer you the famous problem-free installation and operation of Copyflex . . . no exhaust venting, no plumbing or auxiliary equipment, no installation other than an electrical connection. They bring you faster reproduction speed and a host of operator conveniences such as fast return of originals, automatic separation, front or rear delivery. They are the efficient, economical, modern reproduction machines that will help you boost your drafting room output, keep costs at a minimum.

Now is the time to act. Mail the coupon below. You'll be glad you did!

Copyflex Model 500
A new, ultra-fast, heavy-volume machine offering top mechanical speed of 40 f.p.m., automatic separation, front or rear delivery, automatic stacking, and a host of other advanced features.

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Please send me information on Copyflex process and Model 500 machine.

Name _____ **Title** _____
Company _____
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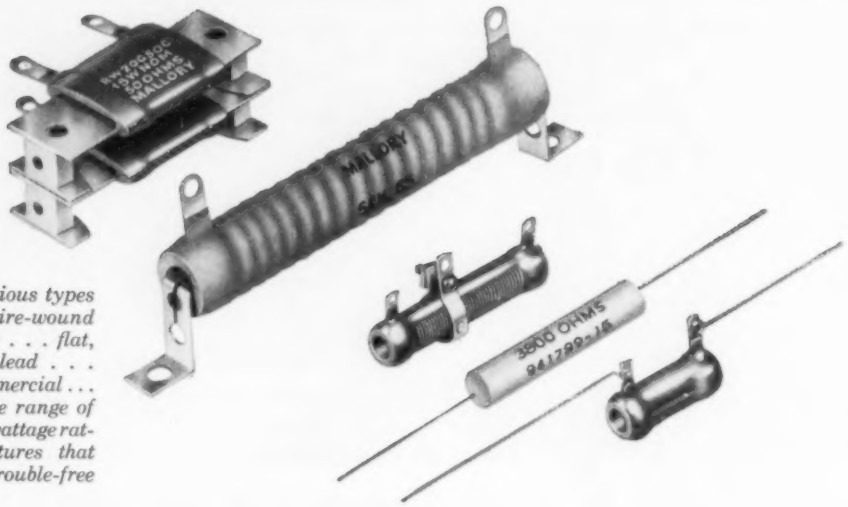
City _____ **County** _____ **State** _____

MALLORY



Each of the various types of Mallory wire-wound power resistors . . . flat, tubular, axial lead . . . military or commercial . . . comes in a wide range of resistance and wattage ratings, with features that assure long, trouble-free service.

Mallory Power Resistors

with the Performance and Ratings You Need

Need wire-wound power resistors? Look to Mallory for performance to meet your specifications . . . types and ratings to match your circuits. A wide line gives you extensive selection.

RW Military Types to meet the requirements of MIL-R-26B, characteristics G and V, include classifications RW20 through RW24, RW29 through RW39 and RW49. Each is available in a broad range of resistances and wattages.

Commercial Vitreous Enamel Tubular Resistors cover wattage ratings from 3 to 200 watts.

Axial Lead Resistors, 4 and 7 watt sizes, are especially designed for economical use in television and other commercial electronic applications.

Adjustable Vitreous Enamel Resistors, in ratings up to 200 watts, feature a special construction to hold the element securely in place to prevent shorting between turns.

Cement Coated Resistors, designed for use where resistance to extreme humidity is not needed, offer good service at economical cost. 5 to 200 watts, in many resistance values.

Mallory resistors incorporate many design features to assure superior life, high physical strength and ability to stand thermal shock. The vitreous enamel coating is a special, non-alkaline material, sealing the wire element in a uniform coating that prevents entry of moisture and electrolytic corrosion.

A consultation with a Mallory resistor specialist can help you select the types best suited to your specific circuit requirements. For data, write to Mallory for Catalog 79-8.

Expect more . . . get more from

P. R. MALLORY & CO. Inc.

MALLORY

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Tuning Devices • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

Parts distributors in all major cities stock Mallory standard components for your convenience.

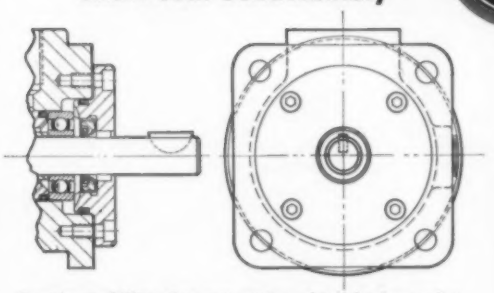
One Waldes Truarc Ring Saves a Pound in Weight Replaces Cast Retainer Plate and Four Screws

Denison Vane Type Pump/Motor

The Denison Engineering Company of Columbus, Ohio uses a Waldes Truarc Beveled Retaining Ring (Series 5002) in their pump/motor to achieve a simpler, lighter, more easily assembled unit and to cut both material costs and production time.

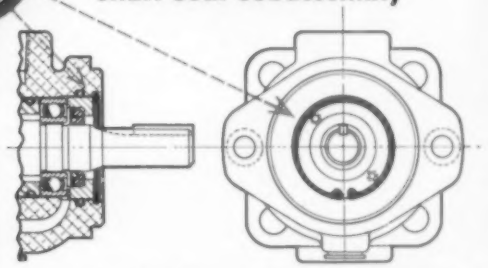
This vane-type power package operates as either a fluid pump or motor without alterations of any kind. Built for 2000 psi continuous duty, rugged construction was essential.

Shaft Seal Subassembly



Experimental Way: One cast retainer plate plus four socket head cap screws hold unit together. Assembly requires skilled labor, machinery, time-consuming careful adjustment.

Shaft Seal Subassembly



Truarc Way: Waldes Truarc beveled retaining ring (internal 5002) retains shaft and bearings, takes up accumulated tolerances rigidly, prevents leakage around shaft. Unit is one pound lighter. Assembly is quick and easy, more economical.

Wherever you now use machined shoulders, bolts, snap rings, or cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better, more economical job. Truarc Rings are precision engineered, quick and easy to assemble and disassemble.

More than 5,000 stock-sizes of the different Truarc ring types available. Ninety stocking points throughout U. S. A. and Canada.

Find out what Waldes Truarc Retaining Rings can do for you toward reducing costs and improving your product. Send your blueprints to Waldes Truarc Engineers for individual attention without obligation.

For precision internal grooving and undercutting . . . Waldes Truarc Grooving Tool!

Send for new catalog supplement

WALDES

TRUARC®

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.

Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.

(Please print)

Name.....

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City.....*Zone*.....*State*.....

PN088

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.

TORRINGTON CUSTOM-MADE BEARINGS

"This Torrington design solves my bearing problem!"

Time and again, industrial firms with special bearing requirements turn their assignments over to Torrington—specialists in designing and building custom bearings.

This confidence has been won by years of successful experience. When you call on Torrington, you engage engineers who have devoted tens of thousands of hours to the design and construction of virtually every type of bearing. From their experience—and imagination—comes the *special* bearing that will bring you peak efficiency, service life and economy.

For a custom *or* standard bearing—any size, any type—you can rely on the skill and experience of Torrington.

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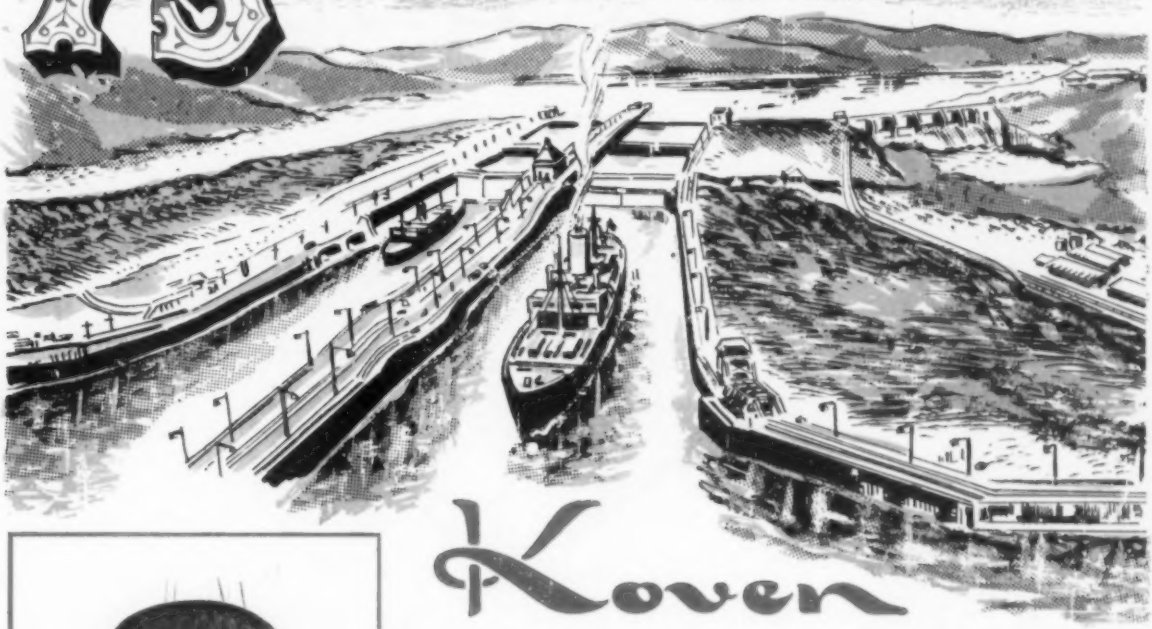
90th ANNIVERSARY 1866-1956

TORRINGTON BEARINGS

Spherical Roller • Tapered Roller • Cylindrical Roller
Needle • Ball • Needle Rollers

75 years ago and 33 years before the completion of the Panama Canal



Koven was making individualized equipment parts

75 years of skill and experience can make a lot of difference. It can, for example, shortcut time and expense for equipment manufacturers much the same way the Panama Canal does for shippers . . .

By producing individualized equipment parts often faster and at lower cost than the equipment manufacturer himself . . . by fabricating each piece according to the exact needs of its purchaser.

This kind of experience makes KOVEN Individualized Equipment Parts the most efficient means to fast, economical production. Investigate. Simply call or write for a consultation with a trained KOVEN representative, and send for Bulletin #550. There's no obligation.

ASME Steel Reducer 13' large diameter; 6' small diameter, 18' high, ⅞" Steel throughout.

SPECIALISTS IN INTRICATE FABRICATION USING:
STAINLESS STEEL * ALUMINUM * MONEL * NICKEL * INCONEL
ALL CLAD MATERIALS * Fabrication to all A.S.M.E. Codes

X-RAY INSPECTION FOR QUALITY CONTROL

KOVEN equipment in all metals and alloys includes: High pressure vessels built to A.S.M.E., A.P.I. Codes; extractors; mixers; stills; kettles; tanks; stacks; breechings; hot transfer lines; light and heavy fabricated piping and plate exhaust ducts. Shop and field erected storage tanks to 2 million gallons. High vacuum testing on liquid oxygen storage tanks.

30' Diameter Head for Special Reactor Vessel

Koven *FOR INDIVIDUALIZED EQUIPMENT SINCE 1881*

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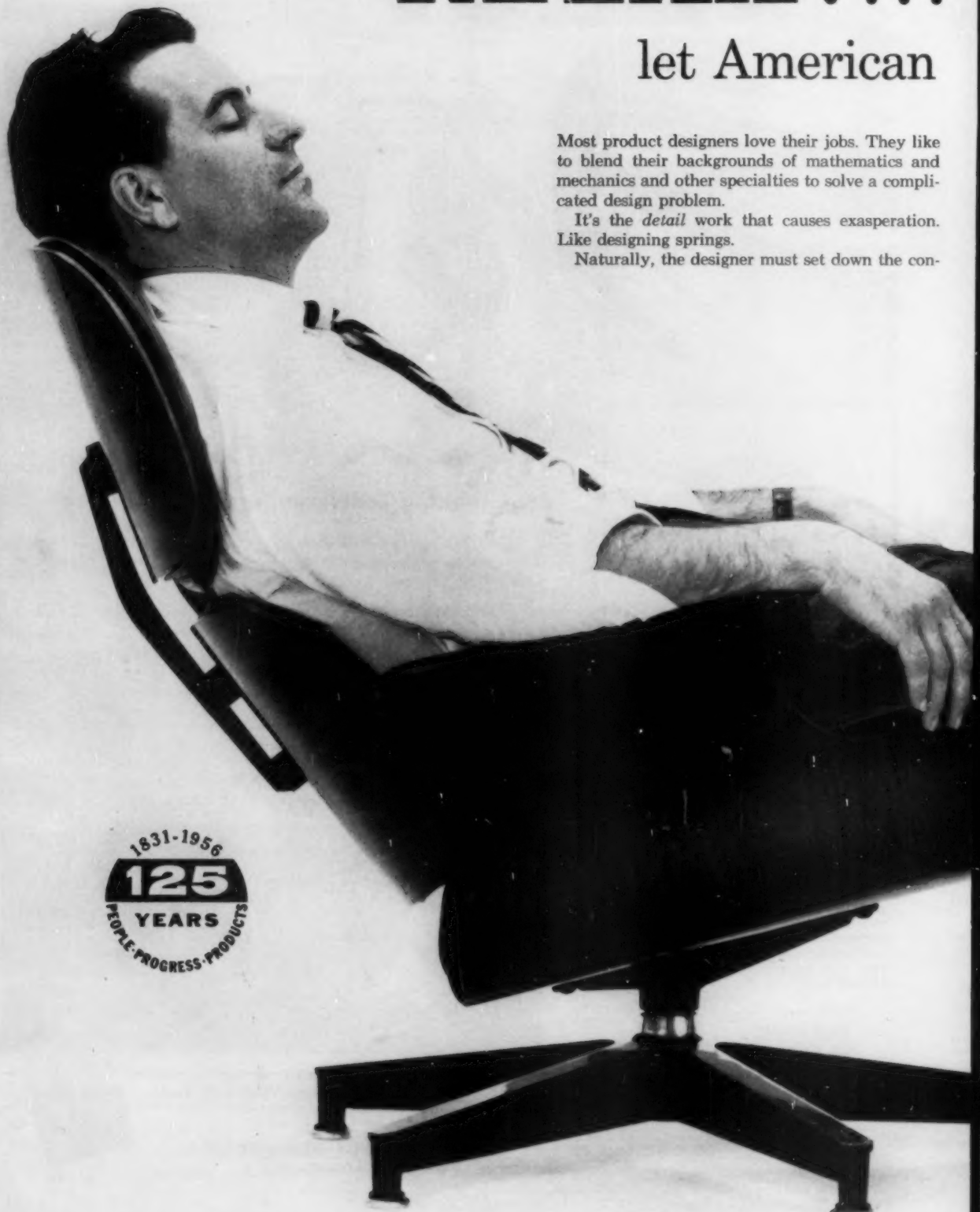
RELAX!...

let American

Most product designers love their jobs. They like to blend their backgrounds of mathematics and mechanics and other specialties to solve a complicated design problem.

It's the *detail* work that causes exasperation. Like designing springs.

Naturally, the designer must set down the con-



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YEARS
PEOPLE·PROGRESS·PRODUCTS

when you have a spring problem
Steel & Wire worry *for* you

ditions of use. He knows how much stiffness he wants, what fastening system is desirable, the limits of spring travel, corrosion conditions and the like. Now, the plot thickens. Can such a spring be produced, in quantity, at a reasonable price?

It is a rare designer who has concerned himself with these practical spring production problems. For this reason, American Steel & Wire maintains a staff of *spring engineers* to relieve you of this detail. They may be able to suggest a minor design change, or a different grade of steel, or a different finish that will give you a better spring than you contemplated at a decided savings in cost.

Just call your AS&W salesman.

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UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS AMERICAN *QUALITY* SPRINGS

UNITED STATES STEEL

Francis Blod, Design Associates, New York City

Mr. Blod discusses the handsome decanter that won 1st Prize, Class II, in the Koppers 1956 Design Competition with associate George Stehl. The prize-winning decanter is being marketed by Hutzler Mfg. Co., Long Island City, N. Y.

Designer Francis Blod talks plastics:

"This container *had* to be made with polyethylene . . . because it offers so much to the user. It has a soft translucency . . . a graciousness that any housewife will appreciate. It does not rattle and it will be less cold to the touch. This container is safe for children . . . possesses lightness, a cover that won't come off and a non-drip spout. Too much cannot be said for the eye-appeal we get from polyethylene-designed items. We use it whenever possible in designing something that is to appeal to women or children.

"Cost is an element that must be contended with, too. We regard polyethylene as one of the most realistically priced mediums we could work with for the adaptability we require on many projects."

New uses for plastics are being discovered almost weekly. Quite possibly one of *your* products could be made more efficiently with plastics. Koppers manufactures DYLAN* polyethylene, SUPER DYLAN* polyethylene, DYLENE* polystyrene and DYLITE* expandable polystyrene. For more information on any of these products, write to Koppers Company, Inc., Chemical Division, Dept. PE-86, Pittsburgh 19, Pennsylvania, or to any of the sales offices listed below.

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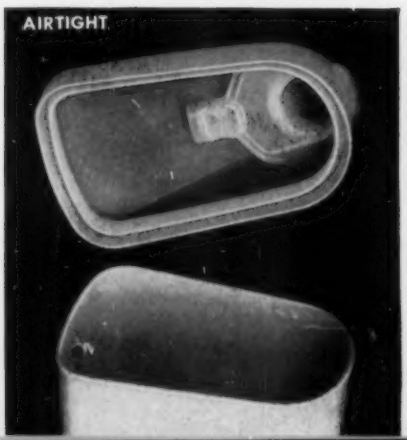
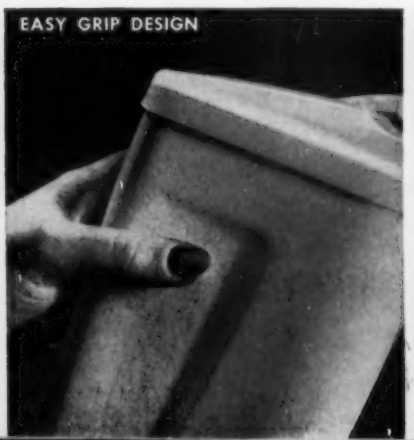
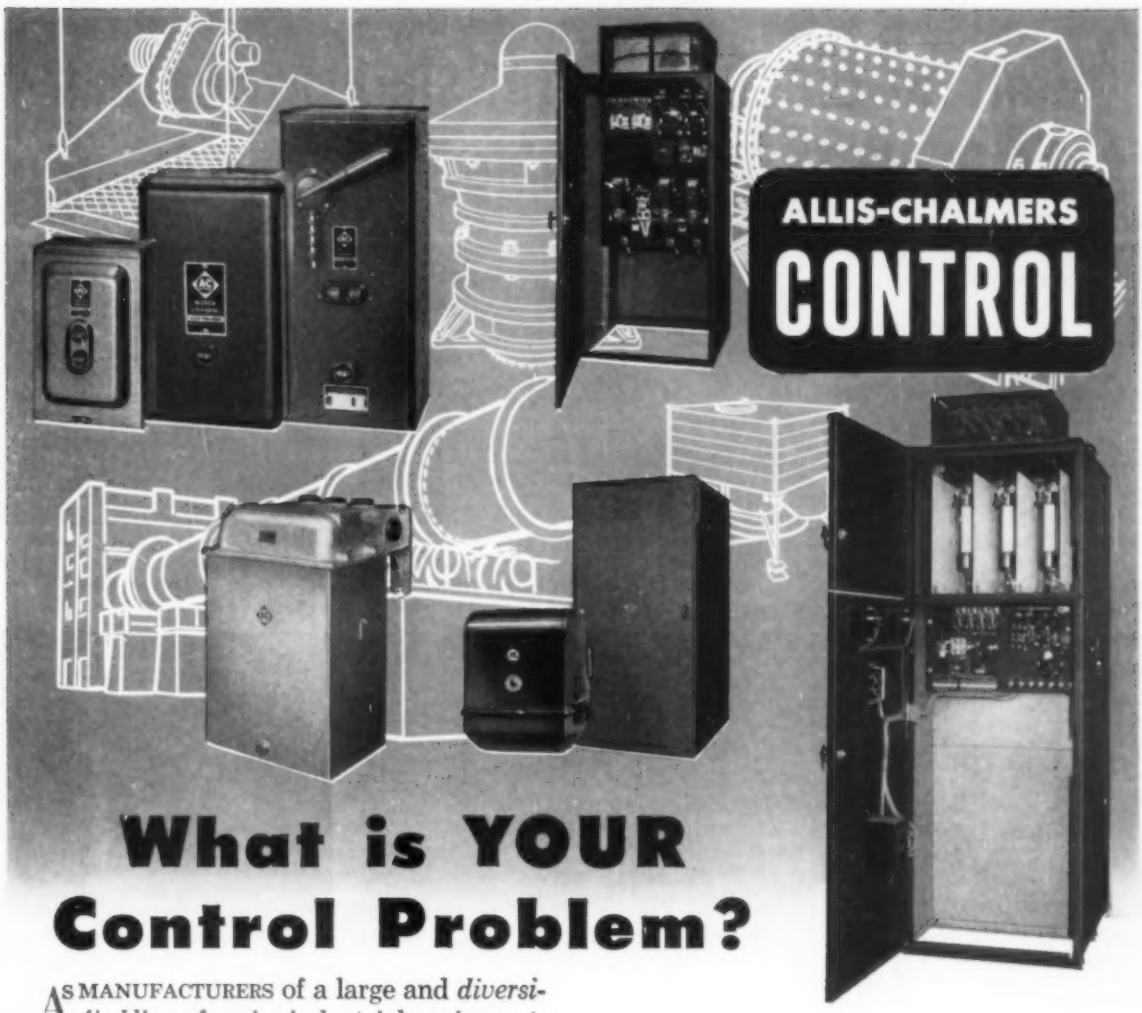
Sales Offices: **NEW YORK · BOSTON · PHILADELPHIA · ATLANTA · CHICAGO · DETROIT HOUSTON · LOS ANGELES · SAN FRANCISCO**







What is YOUR Control Problem?

AS MANUFACTURERS of a large and *diversified* line of major industrial equipment, Allis-Chalmers has been called upon to solve thousands of control application problems in practically every industry. This specialized experience in coordinating power utilization is *yours* when you specify Allis-Chalmers control.

Control for every ac application

Allis-Chalmers offers an extensive line of manual and magnetic control to meet every condition of motor operation. Control functions, varying with specific job requirements, include full or reduced voltage starting, acceleration, speed control, reversing or non-reversing, and dynamic braking.

Custom protection

Built into all Allis-Chalmers control is the type and degree of protection dictated by the application. Controls are available in general purpose and special cabinet, including water-tight, dust-tight and explosion-proof enclosures.

A-4516

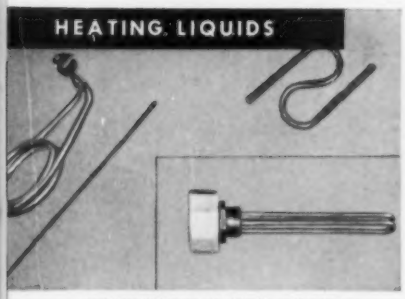
For complete information on any specific control problem, call your nearby Allis-Chalmers representative or write Allis-Chalmers, Milwaukee 1, Wis.

ALLIS-CHALMERS

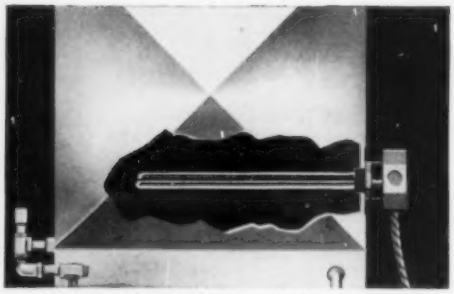
DESIGNING HEAT INTO YOUR PRODUCT?

General Electric Metal-sheath Heaters Save Time in Both Production and Design

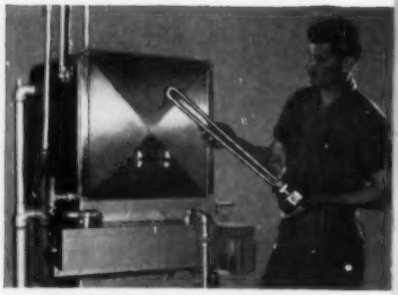
HEATING LIQUIDS



1 **DISHWASHER MAKER CHOSE** screw-in type G-E immersion heater from wide variety available. Threaded fitting speeds installation.

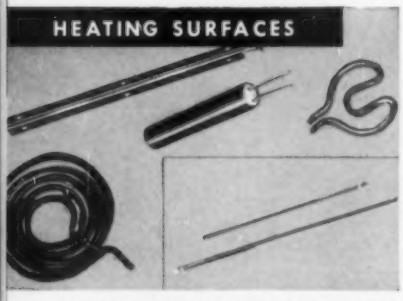


2 **DIRECT CONTACT WITH LIQUID** over entire heating surface provides fast heat-up and minimizes heat-transfer losses. Thermostat is easily installed for temperature control.



3 **SIMPLE ELECTRICAL CONNECTIONS,** after heater is screwed into place, complete installation. Assembly is fast, easy.

HEATING SURFACES



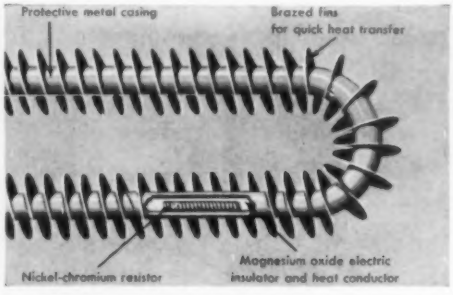
1 **EASILY FORMED WITHOUT BREAKING** . . . this is reason why General Electric tubular heaters are choice of branding-iron manufacturer.

2 **STURDY METAL SHEATH** permits casting heaters right into die body—without production headaches. Result is dependable, even heating of entire die surface.

3 **LONG LIFE** comes from combining quality die work with dependable G-E heaters. Users report up to 12 years life.

HEATING PROCESS AIR

1 **LARGE RADIATING SURFACE** per unit length of G-E finned tubular heaters allows maximum air circulation in forced-convection heating.


Protective metal casing
Brazed fins for quick heat transfer
Nickel-chromium resistor
Magnesium oxide electric insulator and heat conductor

2 **COMPLETELY ENCLOSED** heating element of General Electric finned heaters is protected from dust in the air stream, eliminating trouble from short circuits.

3 **PRE-FORMING TO YOUR SPECS** reduces on-site fabrication time and costs, and helps solve problems of installation.

HANDY SELECTOR GUIDES . . .

Learn how to pick the right G-E heater for your job.

NAME.....

COMPANY.....

ADDRESS.....

CITY.....STATE.....

Mail to Section A723-11, General Electric Company, Schenectady 5, N. Y.

- ☐ **GEA-6113 Handy Selector Guide for Metal Melting**
- ☐ **GEA-6146 Handy Selector Guide for Surface Heating**
- ☐ **GEA-6305 Handy Selector Guide for Water, Alkaline or Plating Baths**
- ☐ **GEA-6306 Handy Selector Guide for Heating Oil**
- ☐ **GEA-6361 Handy Selector Guide for Heating Rooms and Buildings**

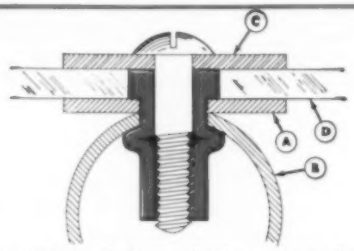
For more information, contact your local G-E Apparatus Sales Office

GENERAL ELECTRIC

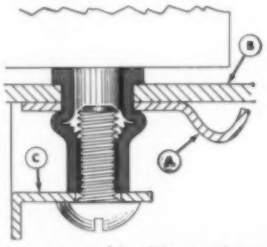
B.F. Goodrich Rivnut

cuts fastening time, saves money by doing two jobs in one operation!

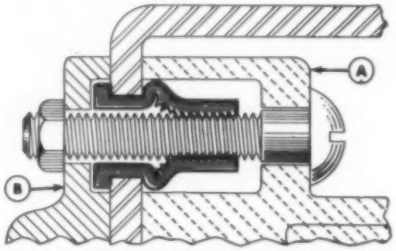
Do you have dual fastening problems like these?



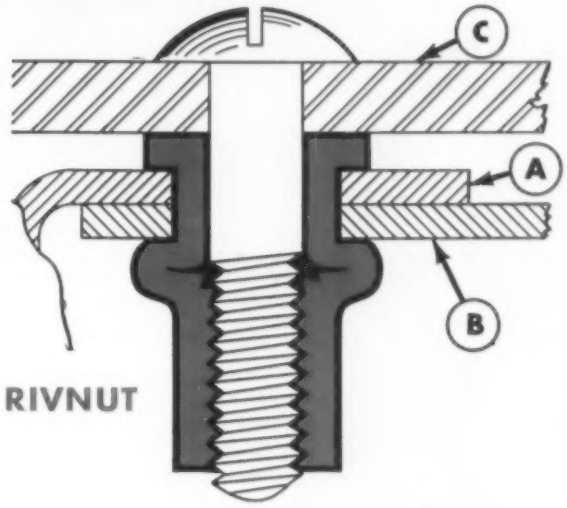
In airplane window seal, Rivnut rivets plate (A) to center post (B), provides nut plate to hold clamp strip (C). Rivnut head serves as spacer for transparent plastic sheets (D). Result: a neat, weather-tight seal!



In vaporizer assembly, Rivnut rivets upper flange (A) to casing (B), makes firm, accurate nut plate for attachment to lower flange (C). Rivnut eliminates reinforcing plate. Result: less assembly time, fewer parts, better product.



Rivnut provides 6-thread nut plate for attachment from either end—or *both*. In spotlight assembly, Rivnut replaces awkward welded stud for attaching socket (A). Plug base (B) is attached on other side. Result: fewer operations, lower assembly cost.



B. F. GOODRICH RIVNUTS cut costs and speed assembly because they rivet two parts together, make a firm, accurate nut plate for a third. And they do both jobs in one quick operation! Rivnuts can be installed from one side, take an attachment bolt from either end. They eliminate welding, tapping, clinching.

In the transformer assembly above, one worker fastens the metal cover (A) to the plastic sheet (B) with Rivnuts in seconds. Rivnuts then serve as mounting lugs for attaching completed transformer to mounting plate (C).

B. F. Goodrich Rivnuts have speeded up thousands of fastening jobs—can do the same for you. Write today to *B.F. Goodrich Company Tire & Equipment Division, Rivnut Sales, Akron, Ohio.*

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how you can use Rivnuts to fasten WITH and TO. Explains construction, simplicity of installation. Get your free copy today by writing to: The B. F. Goodrich Company, Dept. PE-86, Akron, Ohio.

B.F. Goodrich RIVNUTS

The only one-piece blind rivet with threads

THE SURPRISINGLY VERSATILE

Would You Spend 30 cents To Save a Dollar?

HEIM Unibal

HAS MANY USES OTHER THAN STRICTLY ROD END APPLICATIONS

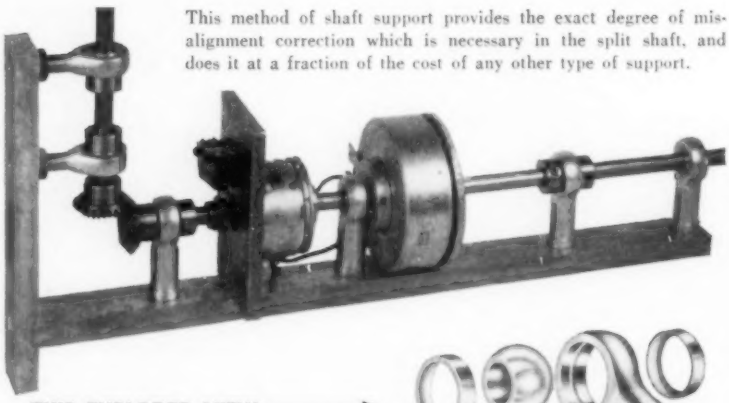
Depending upon size and quantity, some HEIM Unibal Spherical Bearing Rod Ends cost 30¢—even as low as 26¢ each. More and more manufacturers are discovering that a Heim Unibal can very often replace a special part, a weldment, assembled screw machine parts, or other specially machined component . . . which may have cost over a dollar to produce. Savings effected have run into substantial sums.

Take this clutch assembly

with its split shaft and bevel gears, as used in the Van Buskirk marking machine, as an example of how these inexpensive Heim Unibals act as adjustable, self aligning supports for both the horizontal drive shaft and the vertical driven shaft.

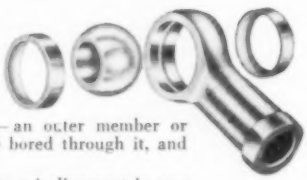
The drive shaft is supported by four female Heim rod ends, which are attached to the frame with hex-head bolts through drilled holes. The assembly is that simple.

The vertical shaft is held in place by two male Heim rod ends. These are screwed into drilled and tapped holes and locked in place with nuts and lock washers.



This method of shaft support provides the exact degree of misalignment correction which is necessary in the split shaft, and does it at a fraction of the cost of any other type of support.

THIS EXPLODED VIEW →



shows the components of the Heim Unibal—an outer member or body, a hardened and ground ball with a hole bored through it, and two bronze bearing inserts.

The universal motion of this single ball corrects misalignment in any direction. Lubrication is in the groove left between the two inserts. Grease fittings can be supplied for relubrication.

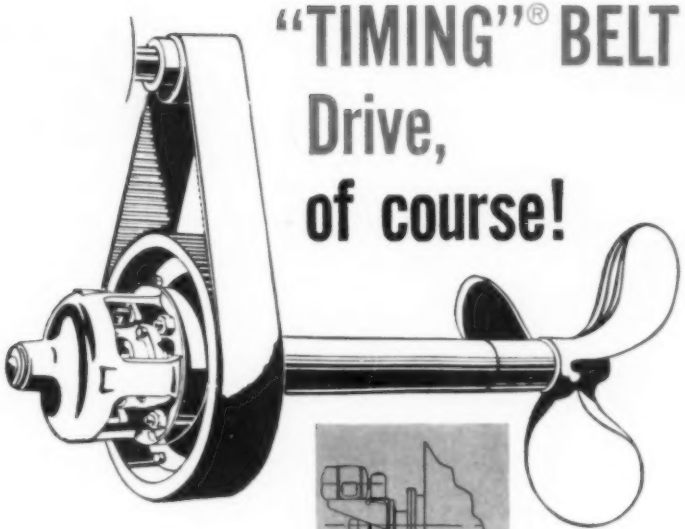
Unibal presents a larger bearing surface and can support greater axial and thrust loads.

PLEASE WRITE FOR COMPLETE CATALOG OR FOR ENGINEERING INFORMATION

THE HEIM COMPANY
FAIRFIELD, CONNECTICUT

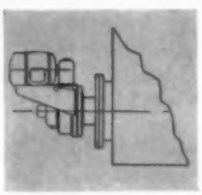
What other single design improvement yields so many selling features?

adopting a Gilmer** "TIMING"® BELT Drive, of course!



*Jensen Engineering Company, Tulsa, Okla.

**The ORIGINAL Timing Belt.



Complete Mixer installed on side of tank.

A good example is the *JENSEN Model "BA" Shortstir Mixer**. Here is a simple 4-1 reduction drive from motor to propeller shaft... yet look at all the new selling features the adoption of a Gilmer "TIMING" BELT Drive provides the manufacturer! (The quotes below are taken verbatim from Jensen's *own literature.*)

"The JENSEN Shortstir Mixer, using the Timing Belt Drive, introduces a simple, rugged method of transmitting power from the motor to the propeller. It is much more compact, weight is greatly decreased, and elimination of couplings provides considerably less overhang from the motor.

"Motor alignment is set at the factory and a 'single bolt' adjustment for initial belt tension is the only adjustment required for the life of the belt.

"A Nylon facing and steel cable tensile members assure an almost unlimited belt life. Positive engagement of belt teeth with pulley grooves prevents slippage, power loss, and overloaded bearings common to most types of belt drives. Compactness greatly reduces vibration.

"No lubrication or belt dressing is required. Oil, however, does not harm the belt. All the advantages of a positive gear drive are accomplished plus the quietness and economy of a belt drive."

Stock or special Gilmer "TIMING" BELT Drives are obtainable through your local NYB&P Distributor. Many design engineers are now making profitable use of the 200-page "Timing" Belt Drive Engineering Handbook. If you are engaged in designing machinery and do not have a copy, write us on your company letterhead.

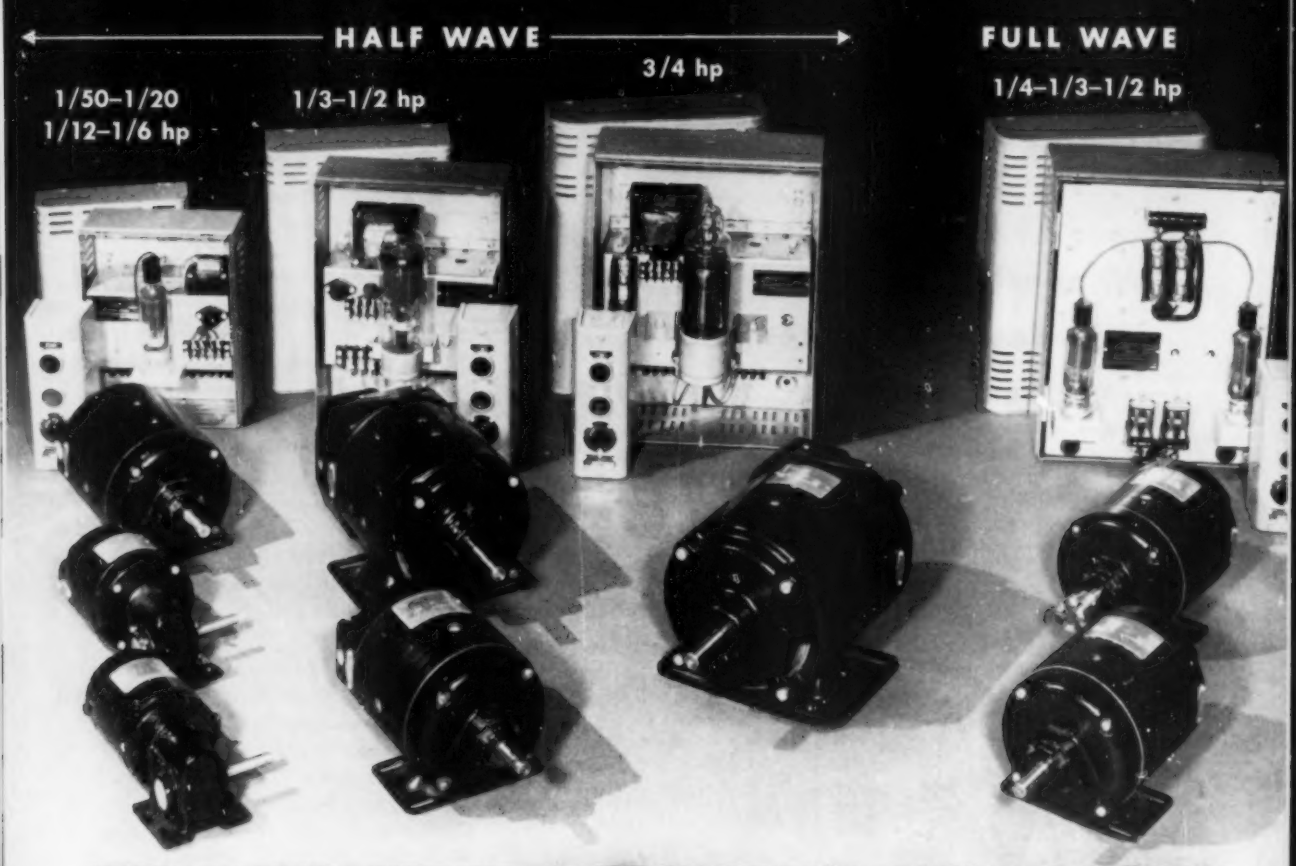
Gilmer **V-BELTS AND "TIMING®" BELTS**

NYB&P INDUSTRIAL RUBBER PRODUCTS

NYB&P — NEW YORK BELTING & PACKING CO. — Founded 1846

NEW YORK BELTING & PACKING CO. 1 Market St., Passaic, N. J.

America's Oldest Manufacturer of Industrial Rubber Products



A DRIVE TAILORED TO EVERY JOB is the achievement of General Electric engineers who designed the new fhp Thymotrol drive line. Here are examples of this versatility:

Three panel sizes now cover the fhp range, making smaller ratings more compact, more economical than ever before.

Full range of ratings

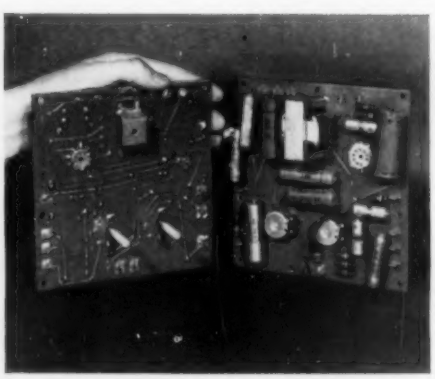
- Horsepower: 1/50 to ¾†
- Power supply: 220 v a-c, 50/60 cycles
- Speed range: 20 to 1
- Speed reg.
  (NL to FL): half-wave — 3%, full-wave—5% (adjustable to flat at any specific speed)

†Plus a full line of integral-hp drives.

Building-block design—you get the exact performance you want by selecting any combination of these optional features:

- Reversing operation
- Jogging (pre-set or run)
- Dynamic braking
- Tachometer follower
- Overload relay protection
- Tube warm-up protection

ONE-TUBE DESIGN of G-E half-wave Thymotrol drives minimizes tube maintenance. This type drive is suitable for most adjustable-speed jobs.



PRINTED CIRCUITRY, DIP SOLDERING are effective techniques which permit new lower General Electric prices. Exhaustive tests prove the sturdiness of this construction for industrial use.

PLUG-IN PANEL BOARD can be quickly removed for maintenance or replacement to minimize downtime—a must on such jobs as production conveyors.

GENERAL ELECTRIC ANNOUNCES . . .

NEW full line of fractional-horsepower G-E Thymotrol* adjustable-speed drives—more compact, more rugged, more reliable, easier and more economical to maintain, yet priced up to 18% below previous models

General Electric announces a completely re-designed line of fractional-hp Thymotrol adjustable-speed drives—*designed to save you up to 18% over prices of previous models.* These versatile new drives are applicable to conveyors, machine tools, in fact, to almost every small machine whose performance can be improved by adjustable speed.

SELECT JUST THE DRIVE YOU NEED —AND SAVE MONEY!

Biggest cost-saving for you with new G-E Thymotrol drives is that you buy only as much drive as you need. For some applications, you'll want only the basic half-wave drive: motor, simple one-tube control, and control station. For more complex jobs, you can select any combination of seven different optional accessories to provide desired performance. To further match drive to job, these popular half-wave drives come in three panel sizes.

For rapid acceleration of high-inertia loads, for extra-smooth performance, or for flat speed-regulation adjustment, you'll want the new full-wave Thymotrol drive, with still other optional features.

NEW DESIGN IS SIMPLE, RELIABLE

In designing new G-E Thymotrol drives for mass production, G-E engineers have also included many new features for longer life, lower operating costs, increased reliability:

Plug-in panel boards on half-wave units can be quickly removed without disturbing customer wiring for fast inspection, repair, or replacement, minimizing downtime.

Printed circuitry and dip soldering result in more compact units which simplify your design problems. Shock and vibration tests show this construction really stands up in industrial use. Parts replacement is simple using soldering iron and pliers.

20:1 speed range is now standard on all ratings. And operator can turn machine to full "off" with speed-control knob.

High tube reliability—all tubes on G-E Thymotrol drives are fully guaranteed for one year, usually last far longer.

SIMPLE PACKAGED DRIVES OR ENGINEERED MULTI-MOTOR SYSTEMS

Whatever your adjustable-speed needs, from packaged single-motor drives to specially engineered multi-motor systems, you'll find the answer —*at new low prices*—at General Electric. See your G-E Apparatus Sales representative today. Or write for Bulletin GEA-6519 to Sect. 791-3, General Electric Co., Schenectady 5, N. Y.

*Trade-mark of General Electric Co.

Progress Is Our Most Important Product

GENERAL ELECTRIC

Design data on adhesives

Armstrong
ADHESIVES • COATINGS • SEALERS

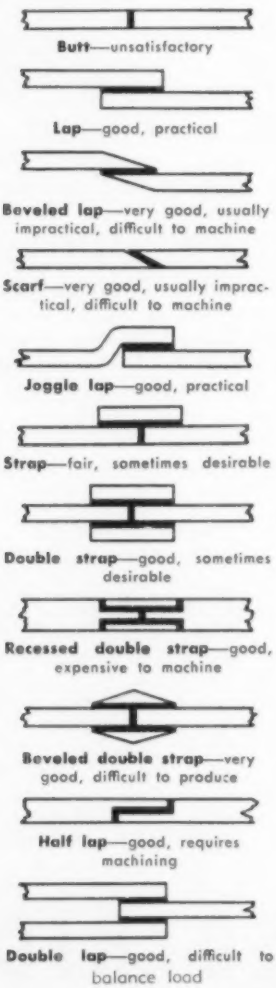
NUMBER FOUR

How to strengthen metal-to-metal joints for flat plates

In order to strengthen any joint to be adhesive-bonded, four basic rules must be kept in mind. These rules are:

1. Make the bonded area as large as possible.
2. Make the maximum proportion of bonded area contribute to strength.
3. Stress the adhesive in the direction of its maximum strength.
4. Minimize stress in the direction in which adhesive is weakest.

Shown below is a variety of flat plate, metal-to-metal joints to which these rules have been applied.



Butt—unsatisfactory

Lap—good, practical

Beveled lap—very good, usually impractical, difficult to machine

Scarf—very good, usually impractical, difficult to machine

Joggle lap—good, practical

Strap—fair, sometimes desirable

Double strap—good, sometimes desirable

Recessed double strap—good, expensive to machine

Beveled double strap—very good, difficult to produce

Half lap—good, requires machining

Double lap—good, difficult to balance load

Adhesive bonding: application of pressure

Effective adhesive bonding always requires some pressure. This pressure may be applied to an assembly in any one of several ways, depending on the nature of the adhesive, design of the part, and its size. Hydraulic presses, hydraulic pads, hydraulic cylinders, air cylinders, spring-loaded jigs, air-filled rubber bags and vacuum bags have all been used satisfactorily.

Whatever the method, though, it must meet these three basic requirements: (1) the amount of pressure should be adequate; (2) pressure should be retained at a constant level; and (3) it should be distributed uniformly over the work.

How much pressure?

The amount of pressure required varies with the kind of adhesive and assembly. Some thermosetting adhesives, for example, require relatively high pressure (as high as 200 psi) for times ranging from 15 minutes to several hours. On the other hand, certain thermosetting epoxy-resin adhesives will form a tight bond at room temperatures with only enough pressure to maintain contact. Contact adhesives require high pressures, but only for brief periods. If in doubt about the amount of pressure, check the adhesive manufacturer's recommendations.

KRAFT PAPER HONEYCOMB CORE is being bonded to sheet aluminum. Panel moves between rubber-covered pinch rolls which deliver uniform pressure. This momentary application of pressure is all that's required for some thermoplastic adhesives.

Note: in some sheet metal assemblies, some pressure may be required to straighten warped sheets and bring them into full contact. This pressure should be added to the bonding pressure recommended by the adhesive manufacturer.

For a pressure device to be satisfactory, it must retain pressure at a reasonably constant level during the curing period, because changes take place during curing which can effectively reduce the applied pressure. Most adhesives flow under pressure. As a result, the over-all thickness of the joint may be reduced and the pressure lowered. Pressure must "follow up" such reduction in thickness. Pressure devices which may hold very tightly at room temperatures may loosen and reduce pressure on the joint at elevated temperatures, due to thermal expansion of the parts. Again, some follow-up is required.

Screw-actuated assemblies like clamps and bolted jigs are not satisfactory when used alone. But if used in conjunction with springs, air-filled rubber pads or any other arrangement that will provide follow-up, screw-type devices will give good results.

Uniform distribution

Uniform distribution of pressure is most important. High and low pressure spots within an assembly can result in lack of uniform contact and differing film thickness—which may result in variability of bond strength. With rigid fixtures or dies, a "pressure pad" like chipboard, rubber-fabric compounds, or glass cloth may have to be interposed between the face of the fixture and the work to equalize pressure. Assemblies bonded in vacuum bags or autoclaves, with the pressure applied directly to the bond and not through fixtures, have excellent pressure distribution.

For more information

Write for a copy of "Armstrong Adhesives, Coatings, and Sealers." Armstrong Cork Company, 8008 Irvin St., Lancaster, Penna.

SATISFACTION GUARANTEED!

... when you order laminated plastics parts from MICO

The fabrication of precision parts of laminated plastics is a specialized job—and Mica Insulator Company specializes in it!

The job calls for modern fabricating machinery. It calls for intimate knowledge of the materials fabricated. It calls for long experience with the special problems involved.

These are some of the reasons why MICO can produce precision parts from LAMICOID®, in most cases, faster, better and at lower cost than you can do it yourself!

And we guarantee satisfaction! Our quality control and inspection are more strict than your own. And, because we manufacture the LAMICOID plastic laminates ourselves, we know exactly how to machine them.

Send us your blueprints, specifications, or sample parts for a quotation. No obligation, of course.

For complete information, mail this coupon.

MICA INSULATOR COMPANY
Department 761 Schenectady 1, New York

Please send me a free copy of "Save Time, Money, Trouble with LAMICOID Fabricated Parts."

Name_____

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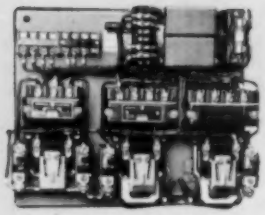
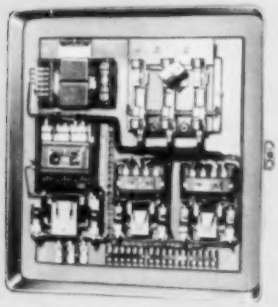
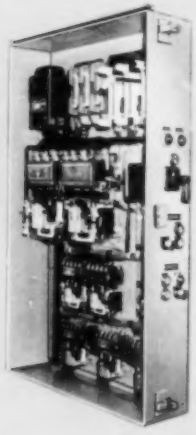
MICA INSULATOR COMPANY • 761 Broadway, Schenectady 1, New York *A Subsidiary of Minnesota Mining & Manufacturing Co.*

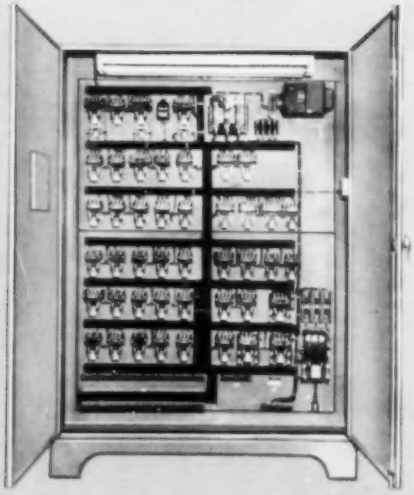
G-E general purpose control on

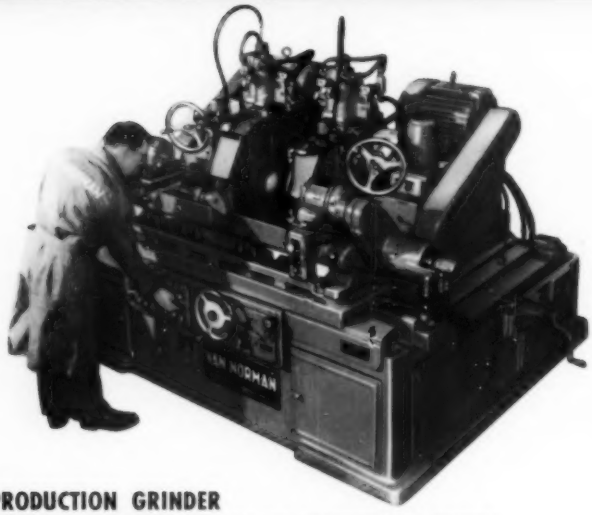
TYPICAL PANELS











NEW HIGH PRODUCTION GRINDER
EQUIPPED WITH G-E CONTROL HOLDS 15 MICROINCH FINISH

This new Van Norman Bowgage Production Grinder is designed for high production grinding of any part that can be readily chucked. The grinder can remove 0.022-inch on a 1⅝-inch diameter piece, hold a 15 microinch finish, and with operator initiated automatic clamping can have a new piece ready for grinding every 15 seconds.

Manufactured by the Van Norman Machine Co., Springfield, Mass., the Bowgage Production Grinder provides the equivalent of two Single Head Production Grinders on a single base. This reduces the floor space required, operator fatigue, handling time, and maintenance.

machines for industry

NEW G-E PAN-A-TROL* PANELS

A new program for packaged machine control from General Electric

Pan-A-trol panels are the focal point of a new program from General Electric for packaged machine control. This program, which places a new emphasis on panels for the dynamic automation age, features outstanding service to customers. The Pan-A-trol name distinguishes these panels which are applied to machines with a maximum rating of 200 horsepower, 600 volts, a-c.

This new program emphasizes the General Electric services available to you with Pan-A-trol packaged control. An enlarged engineering staff is ready to work with you on developing a circuit and panel design to meet your machine requirements. These G-E engineers can also help you take advantage of cost reductions due to repetitive or quantity Pan-A-trol orders.

Faster and better factory service is provided by expanded manufacturing facilities. Up-to-date equipment and skilled employees assure you of fast, prompt shipment. And, of course, General Electric's field service organizations assure your customers of fast local service if desired.

PAN-A-TROL NAMEPLATE identifies each panel. Built from your specifications, these panels offer you the installation, maintenance, and reduced stocking benefits of packaged control.

See your G-E Apparatus Salesman about this new program, and let him tell you how you can benefit from Pan-A-trol packaged control. And, write Section 731-3 for bulletin GEA-6334. General Purpose Control Department, General Electric Company, Bloomington, Illinois.

*Reg. trade-name of General Electric Co.

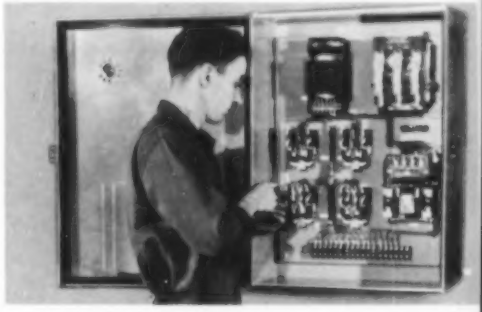
Progress Is Our Most Important Product

GENERAL ELECTRIC

4 WAYS TO BENEFIT WITH PAN-A-TROL PANELS

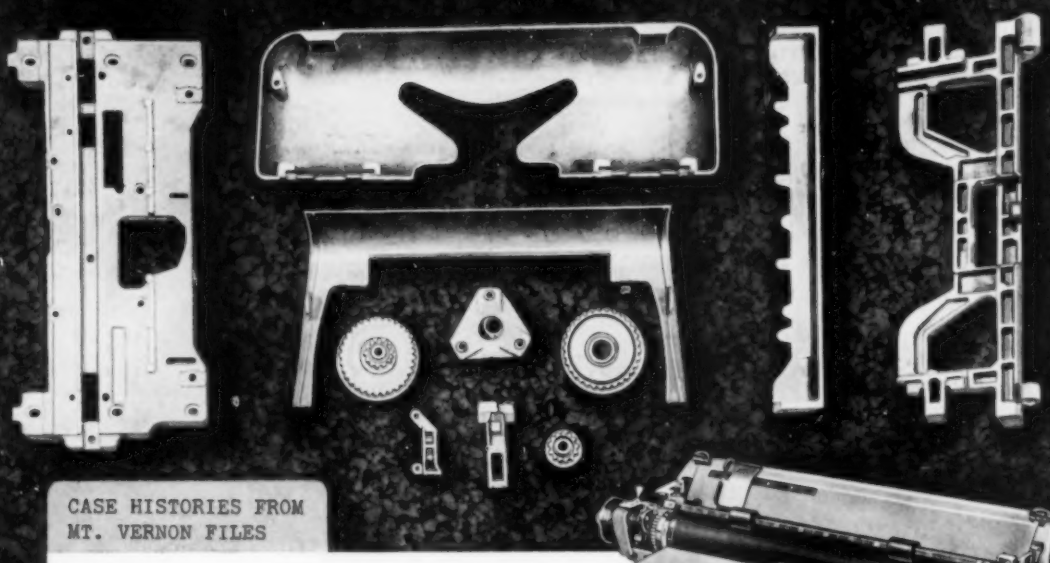
ENGINEERING ASSISTANCE. An enlarged staff of General Electric engineers in the factory and local offices are ready to help you with Pan-A-trol panels for specific applications.

MANUFACTURING FACILITIES. Skilled employees in new, enlarged factory facilities with the latest manufacturing methods assure fast, prompt shipment for Pan-A-trol control panels.



UNIT DESIGN. Pan-A-trol packaged control combines circuit design, device selection and arrangement into one coordinated unit. Only connections to rest of machine need be made.

PAN-A-TROL QUALITY. High-quality components and construction, backed by General Electric's field services, assure long dependable performance with Pan-A-trol packaged control.



CASE HISTORIES FROM
MT. VERNON FILES

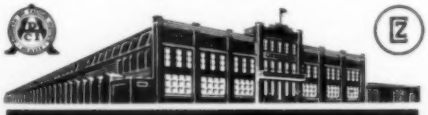
NOW!... 11 Die Cast Parts in Smith-Corona's New Electric!

Smith-Corona calls their newest Electric Typewriter "the fastest in the world." Other features they list as exclusive are "a cushioning action that eliminates all jar at the end of each keystroke"; "complete keyboard control, and a revolutionary new keyboard slope." Their aim is to make this machine the easiest to use of all electric typewriters.

Also interesting to note is Smith-Corona's increasing reliance on die casting. With the urgent need in the electric machine for intricate parts of great strength, rigidity, and high precision . . . the model shown here has no less than 11 die cast parts! These include top plate, keyboard guard, pulleys, pinion gear, and type bar segment mounting — all highly complex castings.

The more complex and manifold your production problems, the more natural — and profitable — it is to call upon Mt. Vernon. For as manufacturers in many fields have discovered, Mt. Vernon has the most complete die casting service — comprising coordinated designing, die-making, casting, and machining, all under one roof. We give you to the highest degree all the advantages of die casting: thin wall sections of great strength and rigidity, and parts produced to such close tolerances that often no machining is necessary. We have 162,000 square feet of the most modern equipment for making dies and for die casting aluminum and zinc.

It will pay you to bring your product specifications to us. We may show you, as we showed Smith-Corona, the way to important cost reductions and improved products.



MT. VERNON
DIE CASTING CORP.
STAMFORD, CONNECTICUT

SALES REPRESENTATIVES

Mr. Grant Eller
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Mr. Jerome J. Theobold
9 East Genesee St., Skaneateles, N. Y.

Mr. Arthur Diamond, Tools Incorporated
86 Bethlehem Pike, Philadelphia, Pa.

Mr. Anker Anderson
Cascade Road, Stamford, Connecticut

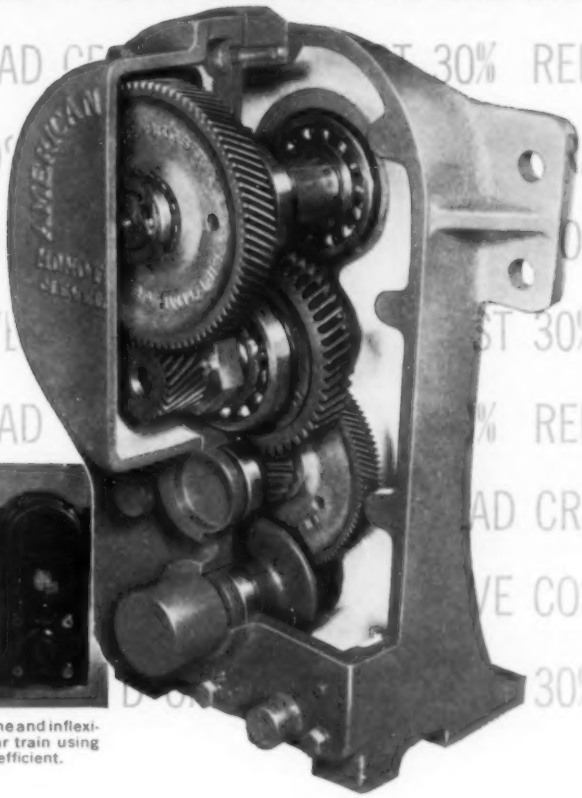
Mr. William Sauers
101 Briarcliff Road, Rochester, N. Y.

Mr. David King
230 Grant Boulevard, Syracuse, N. Y.

Mr. George E. Hahl
39 South Munn Ave., East Orange, N. J.

Duti-Rated Lifetime Gears

REDUCE OVERHEAD CRANE DRIVE COST 30%



Old gear train at left is large, cumbersome and inflexible. At right Foote Bros., designed gear train using Duti-Rated Gears—compact, light and efficient.

100% more capacity - 25% less weight - 28% less size

Ordinary commercial gearing in the traversing drive for an overhead, traveling crane system was bulky and had to be set at a space wasting 45° angle to save head room. Foote Bros. designed a special transmission system using Lifetime Duti-Rated Gears, permitting the application of smaller gears for the same capacity, allowing shorter center distances and a much more compactly designed drive.

The savings in space not only improved the design and performance of the overhead crane but also life expectancy. Maintenance requirements were greatly reduced. An outstanding feature of the new drive was that the Duti-Rated Gears could be interchanged on the same centers to change the ratios . . . allowing various speeds, fast and slow, for traversing.

This is only one example of what Duti-Rated Gears are doing in industry today. Extra gear capacity in less space . . . with longer life and lower costs . . . could be important to you, too. Call Foote Bros. today and learn all the advantages of Duti-Rated Lifetime Gearing . . . pre-engineered as standard or designed for your application. *FREE! Foote Bros. Engineering Manual "Duti-Rated Lifetime Gearing". Write for your copy today!*

This trademark stands for the finest industrial gearing made!

FOOTE BROS. Duti-Rated LIFETIME GEARING

T.M. Reg. U.S. Pat. Off.

FOOTE BROS.

Better Power Transmission Through Better Gears

Foote Bros. Gear and Machine Corporation

4545 South Western Boulevard, Dept. W, Chicago 9, Illinois

There's **MORE** Cooling Surface in these deep-ribbed **MOTORS**

No Day is FRYDAY with these Allis-Chalmers MOTORS

● Frying of insulation is impossible under normal conditions with the extra-large cooling surface of Allis-Chalmers rib-type TEFC motors. The result — longer motor life assures you "repeat" business from your customers.

The engineered partner of A-C motors is Allis-Chalmers control.

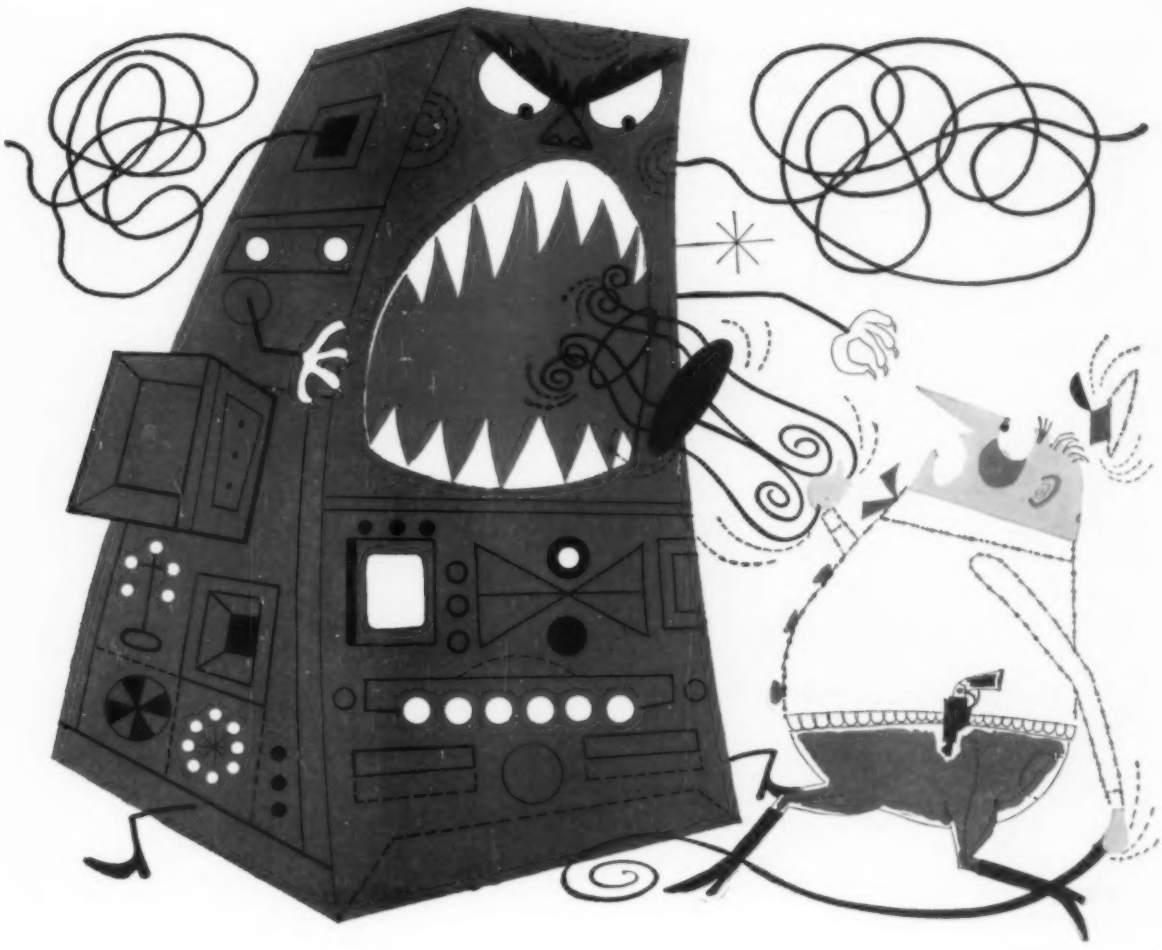
Get Complete Information

To get the most from machinery you build, specify Allis-Chalmers components. Discuss your particular application with your nearby A-C district office, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

A-5052



Taming a wire fabricating machine?

Call American Steel & Wire!

Wire machines can be ornery. They seem to have a brain that delights in fouling up a high speed production line.

Very frequently, your American Steel & Wire representative can tame things down. With over a century of company experience behind him, he may be able to suggest a minor change in wire specifications, die construction or fabricating procedure that will solve the problem.

At AS&W, we *use* a lot of wire in our own plants, and have learned a lot of little tricks that are yours for the asking. Just call your American Steel & Wire representative.

AMERICAN STEEL & WIRE DIVISION
UNITED STATES STEEL, GENERAL OFFICES: CLEVELAND, O.
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA., SOUTHERN DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

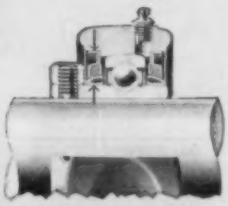
USS AMERICAN MANUFACTURERS WIRE

USS

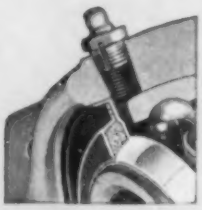
AMERFINE—*high quality fine wire.*
AMERSPRING—*music steel spring wire.*
AMERTEMP—*heavy-duty oil-tempered wire.*
AMERLOY—*alloy heading wire.*
AMERHEAD—*uniform heading wire.*
AMERSTITCH—*extra-tough metal stitching wire.*

UNITED STATES STEEL

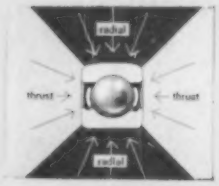
MORE FACTS on why more and more leading manufacturers choose Link-Belt bearings



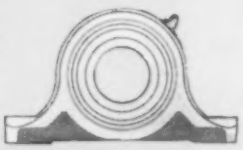
POSITIVE PROTECTION from moisture, dust and dirt is provided by self-aligning seals extending from housing to inner ring. Aligning surfaces are enclosed and lubricated, assuring free alignment.



AUTOMATIC RELIEF OF EXCESS GREASE PRESSURE is provided through lubrication fitting and patented seal arrangement. Extra large grease capacity extends lubrication intervals.



HIGHEST CAPACITY available to carry radial, thrust or combination radial-thrust loads is provided by single-row, deep-groove design.



RUGGED HOUSINGS result from superior foundry practices. Base is cored to assure stress-free, maximum-strength casting.

◀ **DIRTY CONDITIONS** around this portable asphalt mixer manufactured by K. E. McConnaughay Co., Lafayette, Ind., make Link-Belt ball bearings the logical choice.

grease stays in, dirt out

thanks to the effective sealing of Link-Belt ball bearings

HERE's an important extra only Link-Belt gives you on ball bearing blocks! *It's an exclusive seal arrangement*—all aligning surfaces as well as rolling elements are fully lubricated and sealed, assuring long, maintenance-free performance.

All seals are self-aligning—extra assurance that grease stays in, dirt stays out, regardless of alignment. The single-row bearing, too, is self-aligning—in all directions. Free rolling and full load capacity are maintained despite shaft deflection or misalignment.

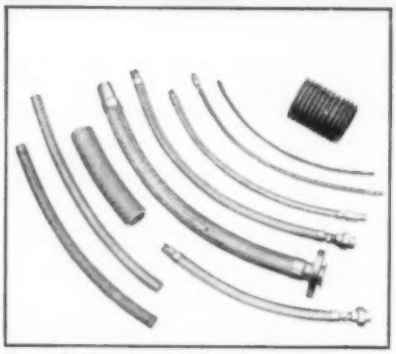
Both Link-Belt ball and roller bearings offer the "fully-protected" sealing feature. Choose from industry's most complete line of pillow blocks, flange, flange cartridge, cartridge, takeup and hanger blocks. Ask any one of the 40 Link-Belt offices for Data Book 2550.

Series 200 and 300 ball bearing blocks.

LINK-BELT

Ball and Roller Bearings

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13.959-A

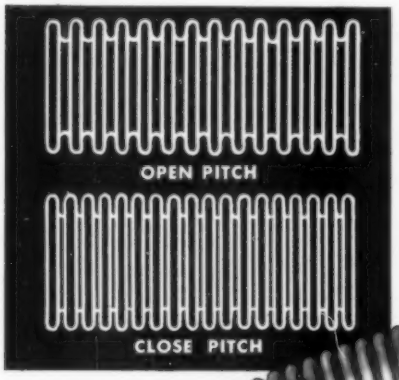


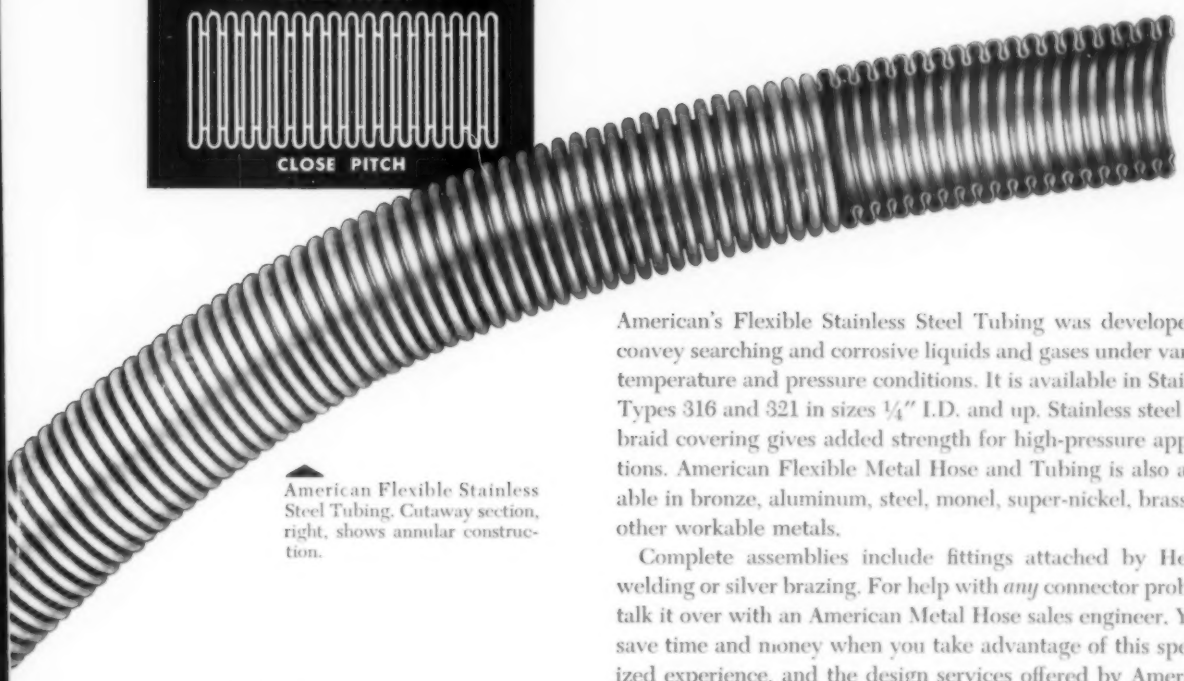
Typical American Stainless Steel Tubing and assemblies designed and manufactured for specific service conditions.

To convey high-temperature, high-pressure CORROSIVE gases and liquids... AMERICAN'S

FLEXIBLE STAINLESS STEEL TUBING

stands up under continuous flexing
absorbs severe vibration
compensates for misalignment
is easily installed





American Flexible Stainless Steel Tubing. Cutaway section, right, shows annular construction.

American's Flexible Stainless Steel Tubing was developed to convey searching and corrosive liquids and gases under varying temperature and pressure conditions. It is available in Stainless Types 316 and 321 in sizes ¼" I.D. and up. Stainless steel wire braid covering gives added strength for high-pressure applications. American Flexible Metal Hose and Tubing is also available in bronze, aluminum, steel, monel, super-nickel, brass and other workable metals.

Complete assemblies include fittings attached by Heliarc welding or silver brazing. For help with *any* connector problem, talk it over with an American Metal Hose sales engineer. You'll save time and money when you take advantage of this specialized experience, and the design services offered by American.

55177 Rev.

OPEN PITCH for general service

CLOSE PITCH for extra flexibility, frequent movement, excessive vibration

STAINLESS STEEL BRAID gives added strength for high-pressure service

ASSEMBLIES made up to your specifications complete with fittings attached

WHEREVER CONNECTORS MUST MOVE

AMERICAN FLEXIBLE METAL HOSE AND TUBING

AN ANACONDA® PRODUCT

FREE FOLDER!

Four-page folder gives engineering data on construction and types. Includes pressure ranges, bending diameters, weights, data on fittings.

Write *today* for your copy. *Please print.*

The American Brass Company, American Metal Hose Division, Waterbury 20, Connecticut.

Please send me a copy of Bulletin STC-1, "Flexible Stainless Steel Tubing by American."

NAME.....

COMPANY.....

STREET.....

CITY.....ZONE.....STATE.....

The Sign of
QUALITY
MOTOR CONTROL

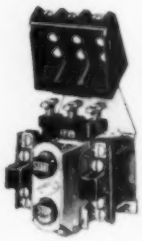
ALLEN-BRADLEY
TROUBLE FREE MOTOR CONTROL

Here are the 3 most popular Allen-Bradley starters. They are QUALITY products widely associated with QUALITY machines. Machine tool builders and buyers appreciate the trouble free operation of A-B motor controls. Send for your copy of the A-B Handy Catalog.

BULLETIN 609 MANUAL ACROSS-THE-LINE STARTERS UP TO 5 HP, 220 V; 7½ HP, 440-550 VOLTS

A Kindt-Collins Master profile grinder equipped with an A-B Bulletin 609 manual starter and an A-B Bulletin 807 drum switch.

Allen-Bradley drum switches come in many styles and ratings. Send for bulletin.



Bulletin 609 arc hood lifted to show the contacts.

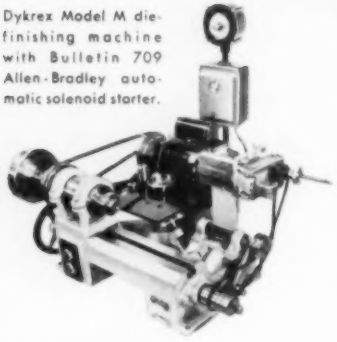
These Bulletin 609 manual starters are popularly used on motorized machines where no safety hazard to workmen is created if the machines should start unexpectedly, after a power interruption.

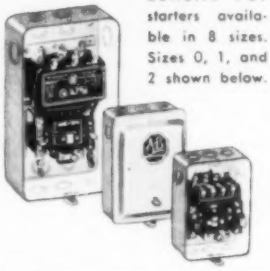
The quick-make, quick-break switch has double break, silver alloy contacts which require no maintenance.

Two thermal breakers give dependable overload protection, no matter how long in service. They are reset by pressing the RESET button.

BULLETIN 709 AUTOMATIC ACROSS-THE-LINE STARTERS UP TO 300 HP, 220 V; 600 HP, 440-550 VOLTS

Dykrex Model M die-finishing machine with Bulletin 709 Allen-Bradley automatic solenoid starter.





Bulletin 709 starters available in 8 sizes. Sizes 0, 1, and 2 shown below.

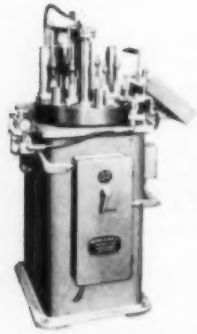
Quality appearance and reputation for reliability make Bulletin 709 starters an asset to any machine.

Bulletin 709 solenoid starters provide the safety feature of no-voltage protection. If the motor is stopped, due to power line interruption, it cannot restart until the operator presses the Start button.

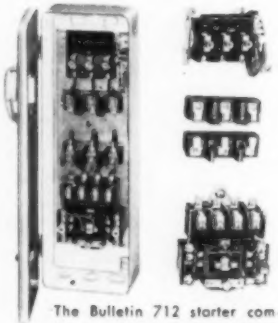
All Bulletin 709 starters have silver alloy, double break contacts that need no filing, cleaning, or dressing. They are good for millions of trouble free operations.

Two overload relays protect the motor against burnouts.

BULLETIN 712-713 COMBINATION AUTOMATIC STARTERS UP TO 100 HP, 220 V; 200 HP, 440-550 VOLTS



Noble & Westbrook Roll-O-Mark marking machine equipped with A-B Bulletin 712 combination starter. Makes a neat & compact installation.



The Bulletin 712 starter combines a visible contact disconnect and a Bulletin 709 starter.

Bulletin 713 combination starters combine, in one enclosure, an I-T-E instantaneous circuit breaker and a Bulletin 709 starter.

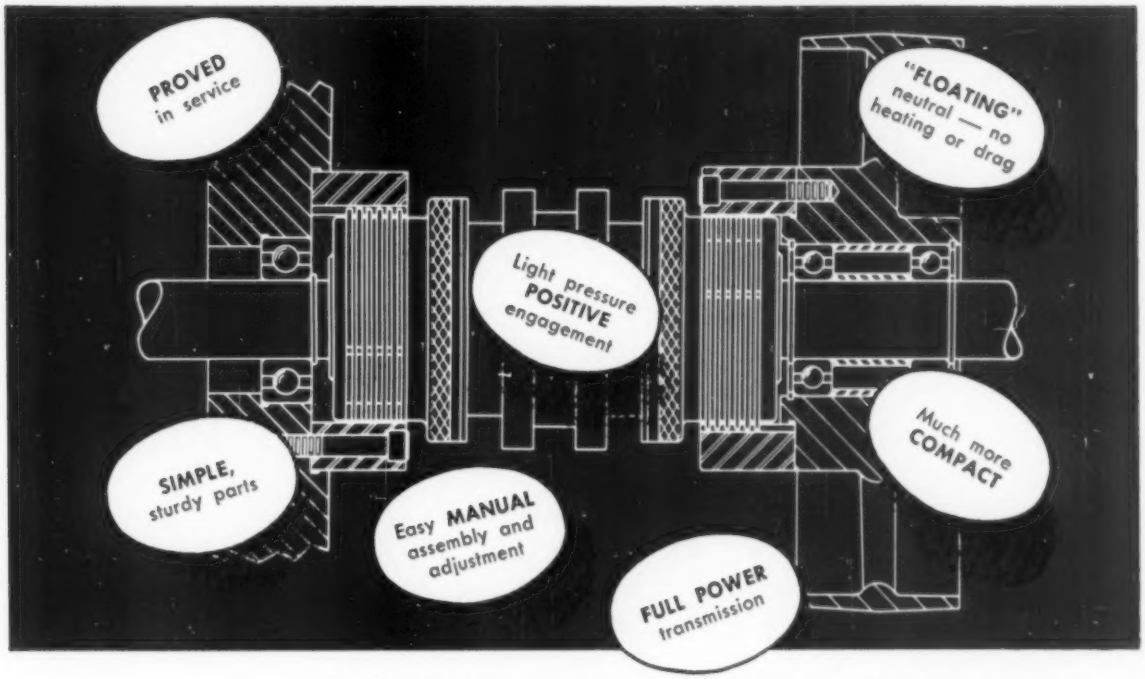
Thermal overload relays are standard equipment on all Bulletin 712-713 combination starters.

Bulletin 712-713 starters provide the additional protection that the cabinet cannot be opened unless the disconnect lever is OFF; the starter is then "dead."

Allen-Bradley Co., 1329 S. First St., Milwaukee 4, Wis. • In Canada—Allen-Bradley Canada Ltd., Galt, Ont.

ASSURE YOUR PRODUCT THE *PROVED* SUPERIORITY OF A

MAXITORQ floating disc CLUTCH


PROVED in service
"FLOATING" neutral — no heating or drag
Light pressure POSITIVE engagement
SIMPLE, sturdy parts
Easy MANUAL assembly and adjustment
FULL POWER transmission
Much more COMPACT

The line drawing shows typical application of a double Maxitorq Floating Disc Clutch, arranged for both drive and brake, with ring-type driving cups.

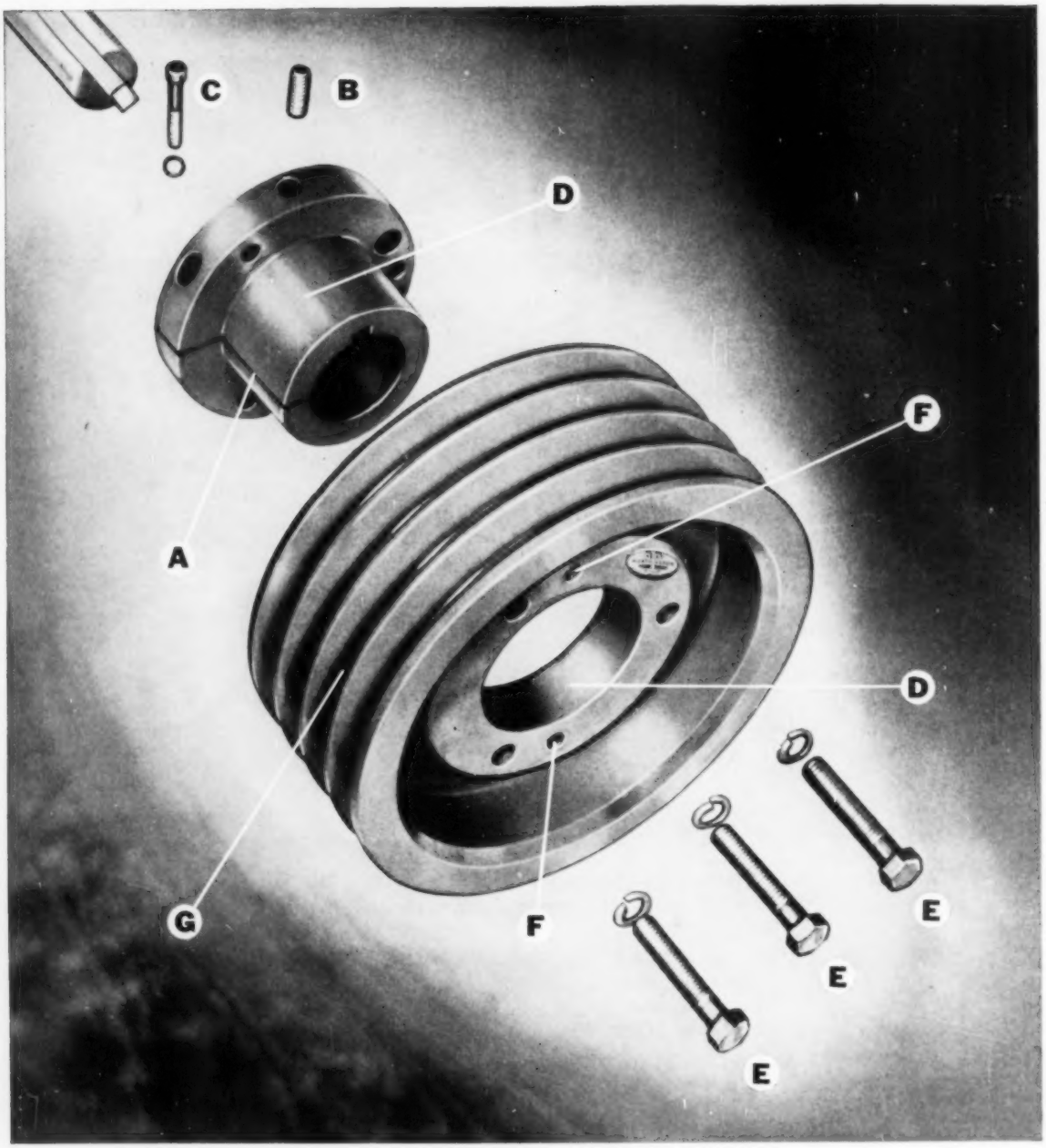
Such installations have a well-proved record of efficiency and freedom from maintenance. Drive and brake engagement and disengagement are smooth and positive . . . without drag or heating . . . because exclusive MAXITORQ design assures that discs ride free in neutral.

MAXITORQ Floating Disc Clutches are available in a wide range of sizes and types . . . single, double, overload release . . . to meet specific installation demands. Our engineering department also stands ready to help you solve special drive problems. Write or phone Dept. PE-8. The Carlyle Johnson Machine Company, Manchester, Conn.

Let's talk **MAXITORQ**

6CJ88

Again in '55, industry's



Exclusive design. All Worthington QD sheaves have these outstanding product features:

A- Completely split QD hub holds shaft tightly under heaviest shock loads.

B- Cup point set screw* in QD hub keeps shaft key in position.

C- Clamp screw* secures hub in proper alignment on shaft when mounting sheave.

D- Tapered fit between hub and sheave allows easy-on, easy-off, hold-tight action.

E- Pull-up bolts draw sheave on to hub to produce positive fit on shaft.

F- Tapped holes in sheave permit pull-up bolts to be used as jack screws to break cone grip when removing sheave.

G- Groove cross-sections are accurate and uniform so that each V-belt seats properly, pulls evenly.

**All Worthington-manufactured QD heavy duty hubs incorporate these exclusive features*

best selling sheave

9 outstanding features make Worthington QD the favorite of design engineers

According to authoritative industry figures, more QD sheaves were sold last year than any other type. Design engineers tell us they prefer the QD—the original two-piece design—because of these 9 outstanding features:

1 EXCLUSIVE DESIGN. As shown at left, Worthington QD sheaves have many outstanding product features which mean real benefits to all users.

2 EASY TO INSTALL AND REMOVE, the QD's tapered hub slides on shaft, locks with a cap screw for permanent alignment. Sheave slides on hub and pulls up with three big bolts for tight holding. Comes off just as easily.

3 BALANCED PERFORMANCE of Worthington Multi-V-Drives, due to accurate uniform grooves and precise mating (with Worthington-Goodyear V-belts), gives you even tension, even pull, even speed, even wear, less vibration.

4 SMART APPEARANCE. The QD sheave's scientific design not only provides more efficient transmission of power but actually adds to the looks of your product.

5 QUICK DEPENDABLE SERVICE—factory-warehouses back distributors.

6 MATCHES YOUR QUALITY STANDARDS. QD sheave quality stems from extremely accurate balance, tough close-grained semi-steel metal, rigid inspection for minimum tolerances, and "I-beam" arm construction of driven sheaves which gives greater strength with less weight.

7 WIDE RANGE OF SIZES with factory-warehouse stocks covering over 100,000 V-belt drive combinations from ½ to 600 hp.

8 WIDE RANGE OF APPLICATIONS. QD sheaves have been job-tested and accepted on every class of equipment and in every industry. Some of the many applications in which QD sheaves have given outstanding performances include: blowers, boring mills, compressors, conveyors, crushers, elevators, grinders, lathes, stokers, oil field machinery and many, many others.

9 COMPLETE ENGINEERING DATA—yours for the asking. In Worthington's 100-page manual, tabbed, easy-to-find tables enable you to select the right sheave and V-belt combination for any job in only three minutes. For your free copy write to Section MV66, Worthington Corporation, Oil City, Pa. In Canada: Worthington (Canada) 1955, Ltd., Toronto, Ont.

MV-6.6

Over 400 stock Worthington-Goodyear V-belt sizes.

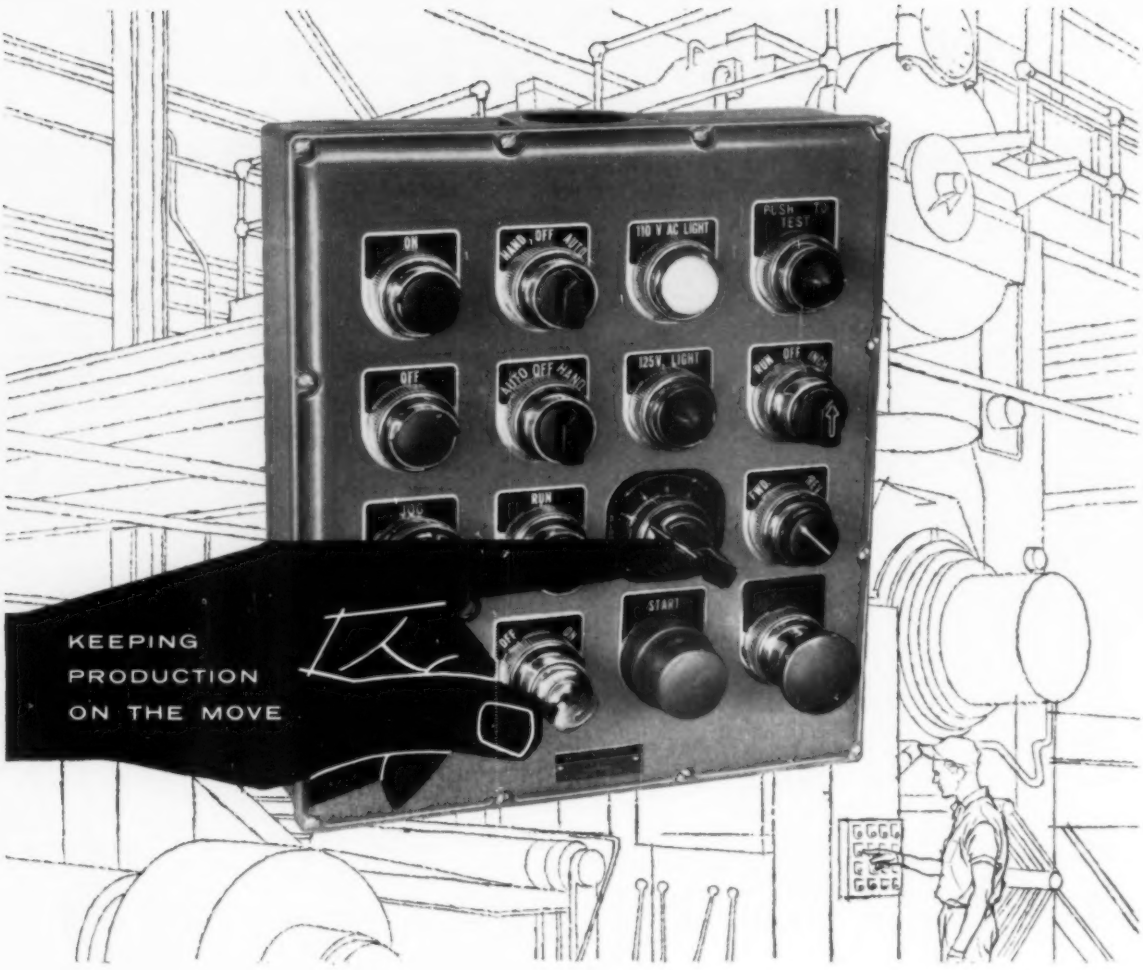
Over 100,000 drive combinations available from warehouse stocks.

13 factory-warehouses back more than 250 distributors.

WORTHINGTON

SPECIFY THESE WORTHINGTON STANDARD PRODUCTS ON YOUR EQUIPMENT

Compressors • Pumps • Multi-V-Drives • Variable Speed Drives



. . . with Westinghouse Oil-Tite control stations—1 to 16 units

Interchangeable parts — stations, contact blocks, operators and indicating lights — right off the shelf, quickly give you a "tailor-made" Westinghouse Oil-Tite* control station to meet the requirements of any heavy-duty industrial equipment application.

Enclosures — die-cast and Bonderized — include cork-neoprene gasketing and close machine fits as positive seals against exposure to oil, coolants, cutting compounds, water and other foreign matter.

*Trade-Mark

New Pushbutton Guide

For more facts on why it will pay you to standardize with Westinghouse control stations, get a free copy of the new *Pushbutton Guide,* booklet B-6749. See your nearby Westinghouse salesman or write to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-30210

WATCH WESTINGHOUSE!

*WHERE **BIG** THINGS ARE HAPPENING FOR **YOU**!*

THERE'S A WESTINGHOUSE PUSHBUTTON TO MEET EVERY APPLICATION NEED!

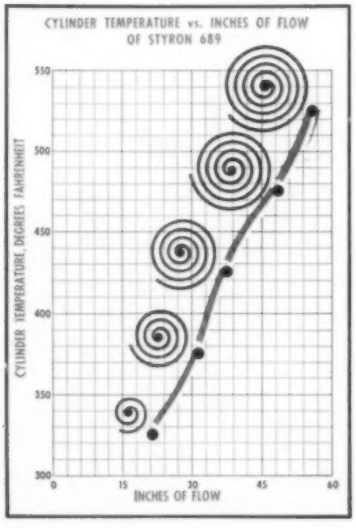
PLASTIATRICS . . . *No. 7 of a Series*

DOW

DEVELOPMENT OF FREE-FLOW STYRON 689 ASSURES FASTER INJECTION MOLDING

New formulation proved excellent for molding thin sections, deep draws, large area parts

For years the plastics industry has been demanding polystyrene materials that would allow faster injection molding. Through Plastiatrics, Dow's clinical approach to healthy plastics application, Styron® 689 was developed to meet this growing demand. An easier flowing material, Styron 689 also has much faster setup time than other materials available. Its uniform flow characteristics (see chart) are especially important in multiple cavity molds with very thin sections and



deep draws. It produces molded parts of uniform physical strength. Its clarity, brilliant sparkle and excellent colorability allow a wide range of transparent, translucent and opaque colors. What's more, Styron 689 is ideal for high speed automatic molding and for large area parts.

Shown here is Styron 689 being tested for uniformity of flow in a standard polystyrene spiral mold at the Dow laboratories. Tests like this result in scientific prediction of performance in the fabrication of finished products.

No. 8 granulation available in Styron 689

A revolutionary granulation of polystyrene material is being offered for the first time in Styron 689. Pellets of No. 8 granulation are 0.080" diameter by 0.080" without external lubricant. It offers faster heat absorption in the heating cylinder—5% to 20% greater lb. per hr. throughout. Reduces silver streaking and eliminates fines. Means reliable volumetric and weigh feeding.

Complete technical literature offered

Detailed technical information is available on molding, extrusion, machining, coloring and finishing with Styron 689. Whatever your problem, you may consult Dow with full assurance of prompt, confidential help and advice. Write, on your letterhead, to THE DOW CHEMICAL COMPANY, Midland, Michigan, Plastics Sales Department PL 434G.

America's first family of better polystyrene formulations

STYRON 666 is the most widely used general-purpose formulation. It has excellent balance of physical properties and moldability.

STYRON 665 is similar to Styron 666 but is especially tailored for extrusion.

STYRON 688 is an easy flow formulation developed for injection molding.

STYRON 689 is a newer and easier flowing formulation than Styron 688. The brilliant sparkle and lack of haze add to the attractiveness of crystal parts molded with this material.

STYRON 683 is a heat-resistant grade of polystyrene.

STYRON 700 has the highest heat resistance of any commercial polystyrene.

STYRON 777 is a medium-impact material used where the high elongation and impact strength of 475 is not required.

STYRON 475 is a high-impact polystyrene formulation. It has three to five times greater impact strength and ten times the elongation of general-purpose polystyrene.

STYRON 429 is a high-impact polystyrene especially suited for extrusion of parts which require better surface gloss and texture.

STYRON 440 is a heat-resistant impact formulation. It was developed for applications such as radio cabinets where the combination of high impact and heat resistance is required.

STYRON 480 has an extra-high-impact strength. In addition to toughness it has good heat resistance and surface gloss.

you can depend on DOW PLASTICS

DOW

Specify

ALLEN STAINLESS

. . . for bright, lustrous finish

. . . for high resistance to corrosion

When designs call for bright finish and ability to stand up to corrosion, you'll find the largest range of sizes in Stainless Cap Screws available anywhere right at your Allen Distributor's. He stocks 97 standard sizes in Type 18-8 Stainless Steel, from #4 x 1/4" to 5/8" x 3" with NC threads; #10 x 3/8" to 3/8" x 1 1/2" with NF threads. Diameters of No. 8 and above have genuine unthreaded Allen Leader Points, to permit easier starting. Regularly furnished with Smooth Head unless Grip Head is specified.

ALLEN

MANUFACTURING COMPANY

Hartford 2, Connecticut, U.S.A.

STAINLESS SET SCREWS

with the deep-driving, tight-holding ALLENPOINT stocked by your Allen distributor in 54 standard sizes from #4 x 1/8" to 1/2" x 1" NC threads; #10 in lengths from 3/16" to 3/4" NF threads.

Sold only through leading Industrial Distributors.

How to Solve a Tricky Temperature Problem

No. 7 of a Series — *Showing the broad application range of Fenwal Controls*

Temperature in a hair dryer is important. Too little heat and hair does not dry properly. Too much heat, and hair may be damaged. Rayette, Inc., St. Paul, Minnesota solved these problems in their Rayette Decor Hair Dryer with a Fenwal THERMOSWITCH® unit — *and obtained an important selling feature.*

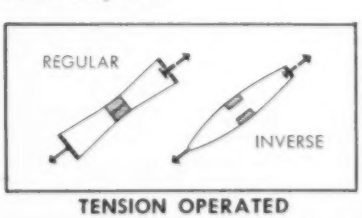
A Fenwal type 17200 block heat THERMOSWITCH unit is used. The unit is factory pre-set at the desired 70°F, and opens on temperature rise and closes when temperature falls to its set point. This gives Rayette their exclusive TEMP-control feature.

With the Fenwal THERMOSWITCH unit, the Rayette Decor Hair Dryer gives faster, more even drying and eliminates wet spots.

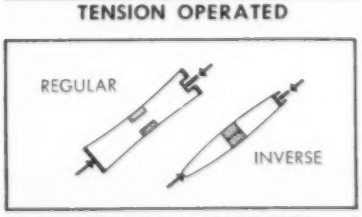
How Fenwal Thermoswitch Units Operate

In THERMOSWITCH thermostats the activating *control* element is the metal shell which encases the contact elements. Changes in temperature cause the shell to expand or contract instantaneously. It is this feature that gives the Rayette Decor Hair Dryer its great precision. The change in temperature exerts tension on the struts, causing the contacts to make or break a circuit. Control in the Fenwal THERMOSWITCH units is calibrated at a given shell temperature by turning the adjusting screw until contacts operate.

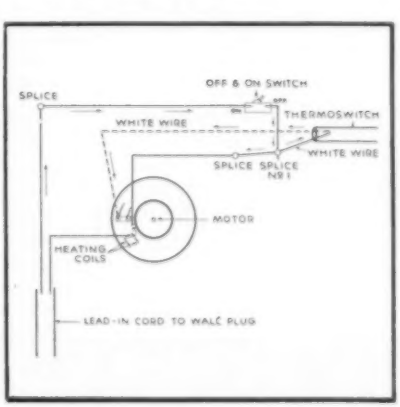
THE RAYETTE DECOR HAIR DRYER shown above utilizes a Fenwal type 17200 block head THERMOSWITCH® unit in its exclusive TEMP-control feature.



TENSION OPERATED



COMPRESSION OPERATED



Send Your Temperature Problem to Fenwal

Fenwal Sales Representatives and Engineers have saved time, trouble and money in all types of products, plants and laboratories by solving thousands of temperature control and detection problems. Fenwal THERMOSWITCH units are controlling processes that involve liquids, gases and solids.

Put Fenwal's vast reservoir of technical know-how to work for you. Chances are your problem has already been met and mastered by Fenwal engineers.

Write for new literature for details and complete product listings on Fenwal Thermoswitch Thermal Controls.

FENWAL INCORPORATED
28 Pleasant Street
Ashland, Mass.

Please send me your catalog MC-135.

Our specific problem is:.....

.....

.....

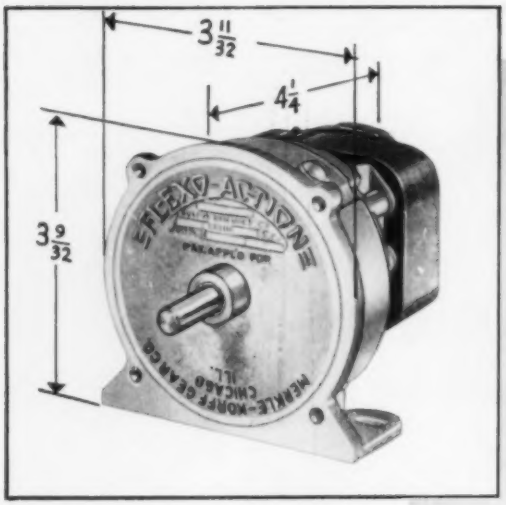
Name.....*Title*.....

Address.....

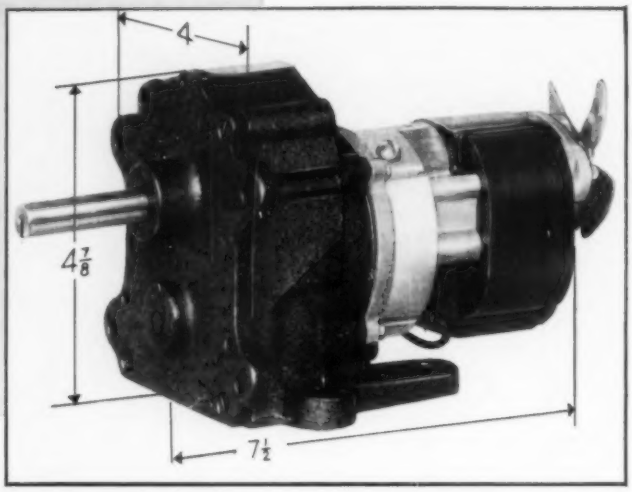
City.....*Zone*...*State*.....

Fenwal CONTROLS TEMPERATURES . . . *PRECISELY*

POWER UNDER CONTROL



This fhp geared motor will produce 30 pounds inch torque at 30 RPM.



This fhp geared motor will produce 300 pounds inch torque at 3 RPM.

News for users of low speed high torque drives

Speeds from about 800 RPM down to any fractional RPM.

Torque from a few ounces to over 300 lb. in.

Practically unlimited number of mounting arrangements.

This great flexibility in Merkle- Korff fhp geared motors eliminates many design problems when incorporating these drives in your product or process.

Merkle-Korff motors may be induction, synchonous, series or shunt wound—either uni-directional or reversing. They are 1/20th h.p. and under.

The sealed case contains precision cut gears and pinions. All steel gears are heat-treated.

These top quality units are built to give many years of service for either continuous or intermittent duty. Hundreds of thousands of Merkle-Korff geared motors are in service today in vending machines, photo copy equipment, pumps, sequence timers, valve operators and a wide range of other industrial applications.

Merkle-Korff design engineers are available to assist your staff in providing a drive unit with the right speed and torque for the job.

Detailed dimension drawings and torque tables are available in a guide for the selection of fractional horse power geared motors. Ask for bulletin PE-1.

Some applications of Merkle-Korff drives will be demonstrated at the Design Engineering Show. See them in Booths 415-19.

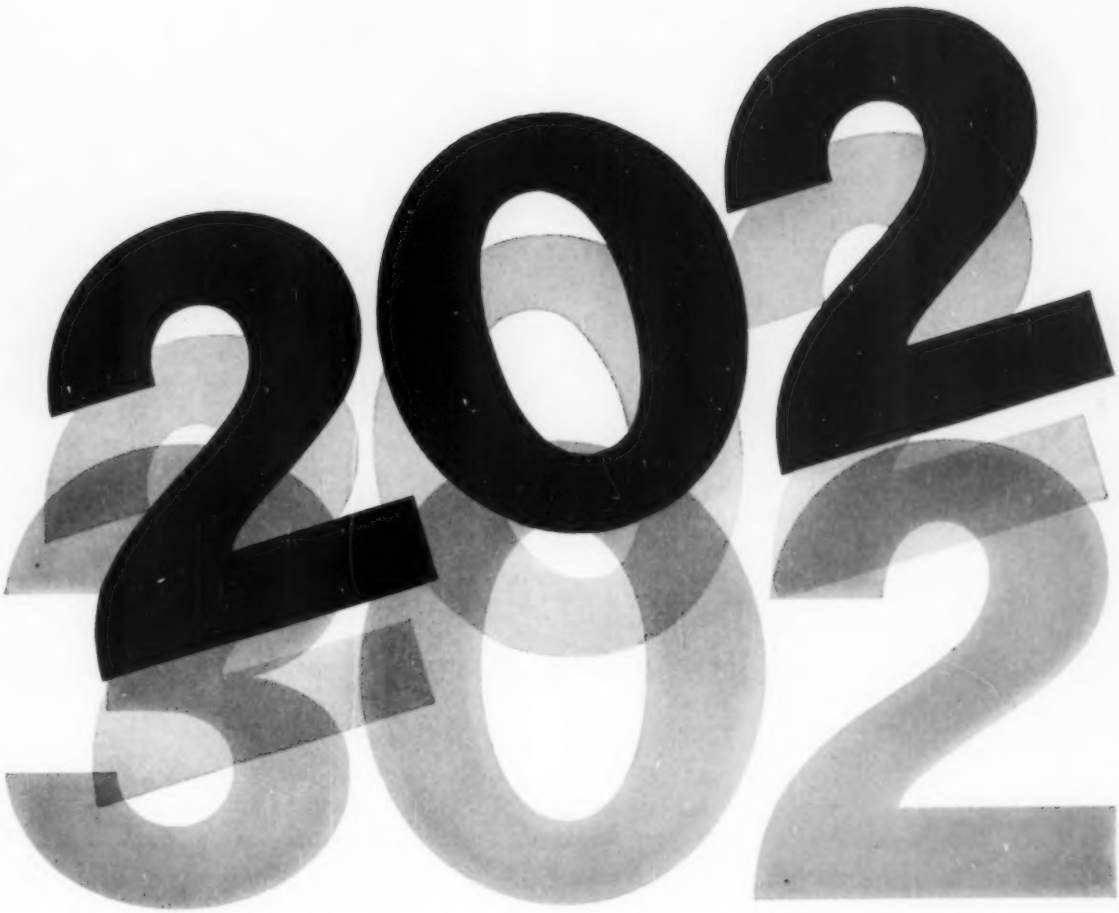
MERKLE-KORFF GEAR CO.

219 NORTH MORGAN STREET • CHICAGO 7 • ILLINOIS

EDWIN M. BOND
Box 333, Rumson, N. J.

RALPH D. EARNEST ASSOCIATES
12818 Puritan Ave., Detroit 27, Mich.

HENRY F. KAELIN
1412 S. Los Angeles St., Los Angeles 14, Calif.



now, Crucible low nickel stainless steels that meet many of your needs . . .

Here are two *new* Crucible grades, Rezistal type 201 and 202 that are similar in quality and properties to types 301 and 302 . . . but with desirable features all their own.

In the annealed condition, for example, Rezistal 201 and 202 have about 10% higher strength than 301 and 302, yet maintain almost identical ductility. This means that these grades can be fabricated with ease equal to their counterparts. In addition, their mill finishes and corrosion resistance to a wide variation of media compare most favorably with 301 and 302.

To sum up: Rezistal 201 and 202 have practically all the desirable properties of 301 and 302, *plus* some of their own. And they're available *promptly* in all forms. Write now for data sheets fully covering the properties of these new stainless grades. *Crucible Steel Company of America, Dept. APE, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

Canadian Distributor—Railway & Power Engineering Corp., Ltd.

Here's an exciting new development in metallized ceramics!

NICOTE METALLIZED CERAMIC COATING

for use with both hard and soft solders!

Here is Frenchtown's revolutionary answer to a problem that has baffled industry for years . . . a satisfactory *single* metallic coating for refractory ceramic bodies which provides a surface for applying solders with melting points between 275° and 1600°.

NICOTE, applied to refractory ceramic bodies by high temperature firing, in most applications requires no expensive preliminary processing such as buffing, electroplating, or tinning to form a strong, firmly-adhering bond with either *hard* or *soft* solders.

Whether the problem requires the fastening of a metal part or other metallized ceramic parts to its surface, NICOTE offers distinct advantages over ordinary silver soft receptive coatings as well as molybdenum and tungsten hard solder coatings. It will withstand molten soft soldering *indefinitely* . . . it's less costly to produce . . . requires no expensive processing.

NICOTE'S mechanical bond to the refractory ceramic body approximates ceramic strength, making it ideal for hermetic seals, high strength mechanical seals, and vacuum type applications.

Like to know more about the amazing possibilities of NICOTE Metallized Ceramic Coating for your product? Bulletin 155 contains complete engineering details. Write for a free copy today. There's no obligation, of course.

This idea starter is free for the asking . . . contains complete facts and details about NICOTE . . . Frenchtown's new **single metallic coating** for use with **both** hard and soft solders. Ask for Bulletin 155.

frenchtown PORCELAIN COMPANY

87 MUIRHEAD AVENUE | TRENTON 9, NEW JERSEY

THE DIFFERENCE... *Carpenter* stainless uniformity

These hinge pivot pins for automatic dishwashers were being turned out by "doing things the hard way." Tools had to be reground every eight hours. The ordinary Type 303 steel used wasn't uniform, refused to hold size, and didn't provide the required finish.

This job could easily have been chalked up as a "necessary headache," but someone wasn't satisfied . . . was willing to explore the possibilities for improvement. As a result, Carpenter Stainless No. 8 (Type 303) has brought these worthwhile changes: Tool regrinding is required only every 18 to 24 hours . . . final grinding of the part is eliminated because size tolerances were held so accurately . . . bar after bar machines the same . . . and each part now costs 50% less.

Build your own improvement program with the cooperation of Carpenter . . . originator of the first Free-Machining Stainless. The steel can be in your plant almost immediately if you call your nearest Carpenter Mill-Branch Warehouse, Office or Distributor now.

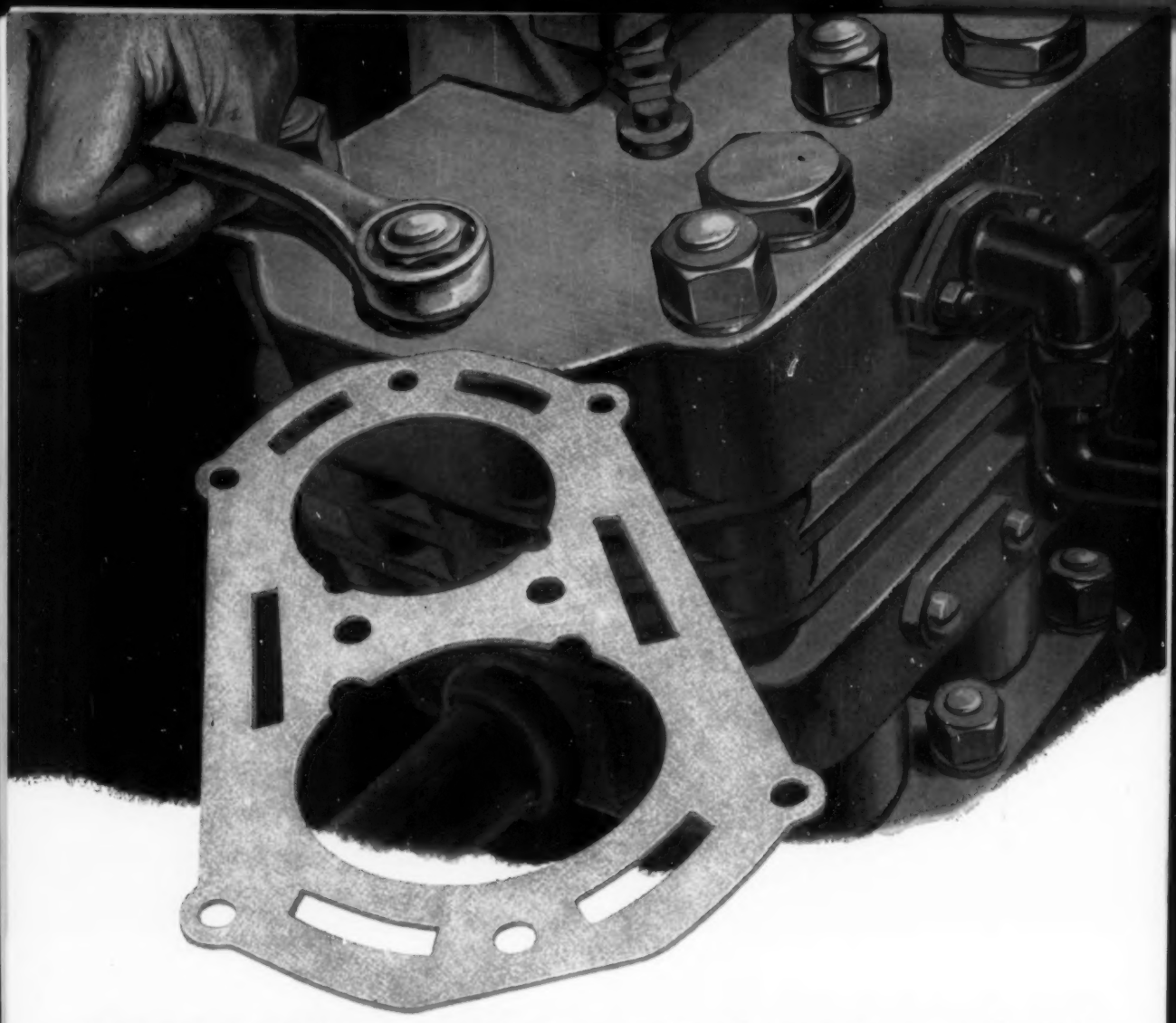
Specify Carpenter...
the one stainless job-proved to give you:

easier machining
fewer rejects
smoother finishes
lower production costs

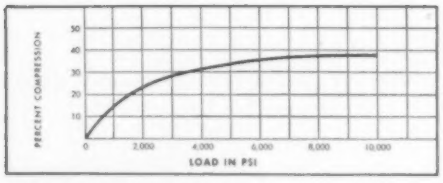
Carpenter STEEL

Free-Machining Stainless Steels

IMMEDIATE DELIVERY from local warehouse stocks—The Carpenter Steel Co., 117 W. Bern St., Reading, Pa.
Export Address: Port Washington, N. Y.—"CARSTEELCO"



Accopac fiber gasket won't dry out or shrink



COMPRESSIBILITY. N-820, less compressible than other Accopac materials, is recommended for heavy-duty applications where minimum flange pressures will be 2,000 psi and where temperatures will not exceed 250° F.

Combinations of heat and pressure that cause ordinary plant fiber gaskets to fail are handled successfully by Armstrong Accopac® N-820—a dense new material made by a patented Armstrong process. It requires a minimum flange load of 2,000 psi and seals at temperatures up to 250° F.

The special latex binder in N-820 will not leach out in alternately wet-and-dry applications. Shrinkage due to binder loss is eliminated because N-820's binder is non-volatile and non-extractable. It stays in.

N-820 is already being used successfully on a wide range of heavy-duty applications, often as an economical replacement for asbestos sheet packing where temperatures do not exceed 250° F. For more information and a copy of "Armstrong Gasket Materials," write to Armstrong Cork Co., Industrial Division, 7008 Irvin Street, Lancaster, Penna.

Armstrong ACCOPAC

. . . used wherever performance counts

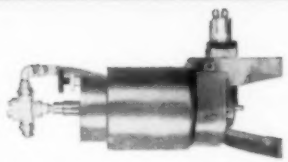
ELECTRONICALLY CONTROLLED hydraulic power FOR AUTOMATION

When Champlain Company, Inc., developed their amazing REGISTRON for *automatic* color register control on rotary presses, they needed a fluid motor that was *precise*. After exhaustive testing of many types, only Eastern Fluid Motors met their high standard for performance.

Eastern Fluid Motors are lighter, more compact, and give rapid response because small components give low inertia loads. They quickly transform electronic signals into smooth flowing, precise hydraulic power.

Registrors are installed on high-speed rotary presses that simultaneously print as many as eight colors on a web of paper that travels at speeds up to 1500 feet per minute. Each color must be perfectly registered to tolerance of .0025" or printing appears fuzzy. The Champlain Registron inspects the moving web and the rotating printing cylinder, predicts the occurrence and direction of an off-register condition, and starts and completes a correction quickly.

Eastern is proud to have a part in Champlain's Registron which has developed *automation* in answer to printing's toughest problem.



Close up of a phase detector with Eastern Fluid Motor atop it. The fluid motor supplies instant power to move the printing cylinder and correct off-registration within a tolerance of .0025".

Rear view of 8-color, 36" rotogravure press showing individual Registron control units cable-connected to their respective phase detectors. A second cable carries impulses to the units from each web scanner.

HYDRAULIC PUMPS

FLUID MOTORS

AIRCRAFT-TYPE PUMPS

If your application calls for precision hydraulic equipment that performs within strict tolerances, Eastern equipment may provide your best answer. For helpful operating data on fluid motors, hydraulic pumps, and aircraft-type pumps, request catalog series 31.

Eastern

EASTERN INDUSTRIES PUMP DIVISION

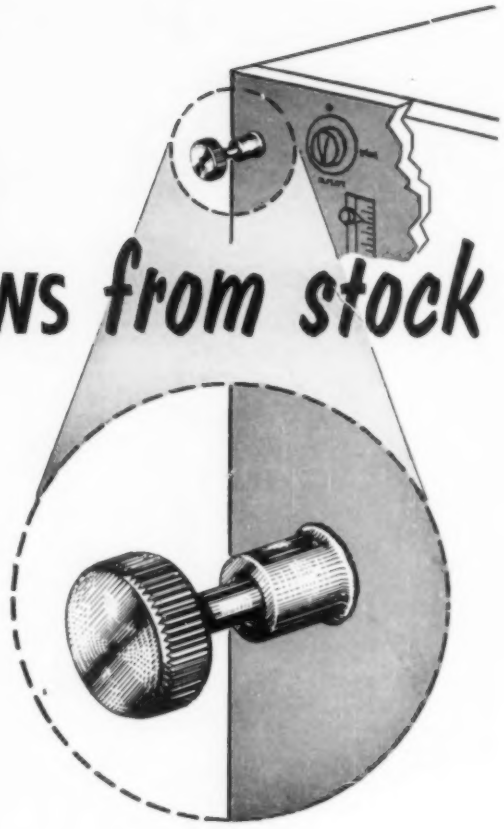
INDUSTRIES, INC.

100 SKIFF ST., HAMDEN 14, CONN.

reduce costs

with SOUTHCO®

CAPTIVE PANEL SCREWS *from stock*



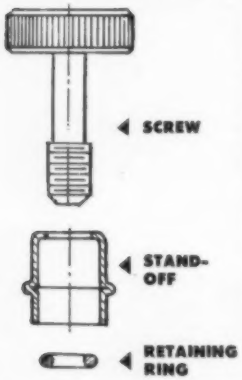
Here's a low-cost retractable screw fastener to save you assembly time and to eliminate the frequent need for costly special design fasteners. Unmatched for fast, economical use by assemblers of electronic units and other paneled cabinets.

"Floating" screw insures easy alignment no matter how many screws are engaged in a single panel. No special skills or tools needed; installation fast and simple.

3 head sizes and 3 standard thread sizes available. On special order, slotted heads, stainless steel screws, and extra long screws.

Write for complete information. Southco Division, South Chester Corporation, 236 Industrial Highway, Lester, Pa.

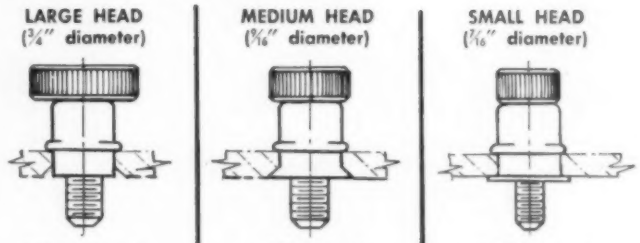
3 SIMPLE COMPONENTS



EASILY INSTALLED

Stand-off is flanged into panel. Screw is inserted into oversize hole in stand-off and locked in place by retaining ring, which is passed over threads to seat behind last thread.

A SIZE FOR EVERY NEED



Screw and stand-off are brass, nickel plated. Retaining ring is durable vinyl plastic.

Choice of stand-offs for each screw size to accommodate panel thicknesses from 1/16" to 17/64".

SOUTHCO® DIVISION

LION

SOUTH CHESTER CORPORATION • LESTER, PENNSYLVANIA

Miller

FLUID PRESSURE BOOSTERS

BOOST 80 PSI AIR

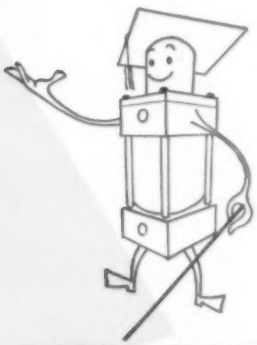
Input Range: 40 to 3000 psi Air or Fluid

TO 2000 PSI HYDRAULIC PRESSURE

Output Range: 200 to 10,000 psi Fluid

- Save space, weight and investment cost by replacing pump installations in many applications.
- Less costly to install, operate and maintain.
- **Hold Pressure indefinitely** without the motion and heat generation of ordinary pump circuits
- Provide—at point of cylinder thrust—more efficient power with less weight in less space than direct driven air cylinders
- Save up to 95% of air consumed by direct driven air cylinders
- Operate at speeds of 30 to 450 strokes per minute

NOTE: In addition to its most complete line of "Custom-Built" Boosters available on normal delivery Miller offers 5" bore, 25 to 1 ratio, boosters for immediate delivery in either 6" or 12" stroke Write for data and prices.



ESPECIALLY RECOMMENDED FOR

- **WELDING**
- **PUNCHING**
- **SHEARING**
- **CLAMPING**
- **RIVETING**
- **CRIMPING**
- **PRESSING**

and similar applications

FULL DETAILS IN MILLER BULLETIN B-200 SENT FREE ON REQUEST
Other Miller products include: Air cylinders, 1½" to 20" Bores, 200 PSI operation; low pressure hydraulic cylinders, 1½" to 6" bores for 500 PSI operation, 8" to 14" bores for 250 PSI; high pressure hydraulic cylinders, 1½" to 12" bores, 2000-3000 PSI operation. All mounting styles available.

SALES AND SERVICE FROM COAST TO COAST

CLEVELAND • YOUNGSTOWN • DAYTON • PITTSBURGH • PHILADELPHIA • BOSTON • HARTFORD • NEW YORK CITY • BUFFALO • ST. PAUL • GRAND RAPIDS • DETROIT • FLINT • FORT WAYNE • SOUTH BEND • INDIANAPOLIS • MILWAUKEE • LOUISVILLE • KANSAS CITY • SEATTLE • LOS ANGELES • SAN FRANCISCO • BALTIMORE • DENVER • ST. LOUIS • MOLINE • CHICAGO • HOUSTON • TORONTO, CANADA and OTHER AREAS

Miller

MILLER FLUID POWER DIVISION FLICK-REEDY CORP.

2002-04 N. Hawthorne Ave., Melrose Park, Ill.

AIR & HYDRAULIC CYLINDERS • BOOSTERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS

Dempster-Dumpster—a truck-mounted fork lift designed to handle trash and other bulk materials, shown in dumping position. INSET: "Dacron" is the reinforcement in the V-belts on the 13-inch, 2-groove drive—increasing delivered horsepower, efficiency of hydraulic pump.

How the Dempster-Dumpster's V-belt drive efficiency was increased by premium V-belts reinforced with DACRON

REG. U.S. PAT. OFF.

The lifting and steering power of the Dempster-Dumpster generates from a single hydraulic pump driven by V-belts. To insure dependable, slip-free operation and positive starting at this important spot, Dempster Brothers, Inc., switched to premium V-belts reinforced with Du Pont "Dacron"* polyester fiber. During the six years since the change, the belts have been proving their superiority on hundreds of Dempster-Dumpsters in use throughout the country.

Slippage and stretching have been sharply reduced by the 40% greater strength of belts made with Du Pont "Dacron". Two premium V-belts now do the work formerly handled by three standard belts. The belts remain stable . . . deliver more horsepower from the pump. And the ability of these belts to withstand greater shock loading assures fewer replacements, more efficient, trouble-free operation.

In designing *your* next drive, investigate the advantages of premium V-belts made with "Dacron". They combine the unique properties of the "Dacron" yarn made by Du Pont and the highest skills of the leading V-belt manufacturers. For a list of manufacturers using "Dacron" in premium V-belts, write to E. I. du Pont de Nemours & Co. (Inc.), Textile Fibers Dept., Wilmington 98, Delaware. Premium V-belts shown in above photo were manufactured by the U. S. Rubber Company.

6 REASONS FOR USING PREMIUM V-BELTS REINFORCED WITH "DACRON"

- Transmit up to 40% more horsepower.
- Withstand greater shock loading.
- Longer flex life.
- Cut downtime.
- Low stretch.
- Require less maintenance.

"Dacron" in V-Belts DU PONT

REG. U. S. PAT. OFF. REG. U. S. PAT. OFF.

"Dacron" is Du Pont's registered trademark for its polyester fiber.

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

VOICE under the SEA

Relies on ALSIMAG®

For dependable service on the ocean floor AlSiMag precision insulators are used in the new Transatlantic Voice Cable

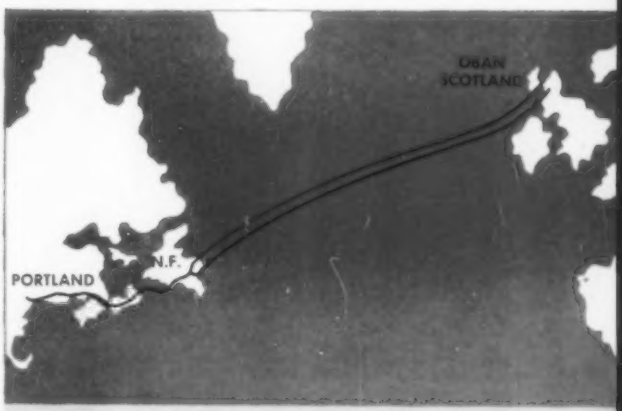
For 25 years communications engineers have studied the problems of laying a voice cable under the Atlantic Ocean to link the Americas with Europe. Today, the "voice" is nearing reality. The new link, a twin cable system, will be completed this year.

The almost incredibly exacting standards involved in making parts of the transatlantic cable have produced some truly remarkable engineering—engineering that accepts results no less than perfect. A select group of suppliers share in the achievement and AlSiMag is proud to be among them.

Men who perform "impossible" tasks stake their success on their creative ability plus the quality of their products. When technical ceramics are required on such critical applications, almost without exception the choice is AlSiMag. There are many reasons for this: One is the wider choice of materials available in AlSiMag. The exact composition for the required performance may be chosen from the many available . . . **right in physical characteristics, right in electrical characteristics, right in every way!**

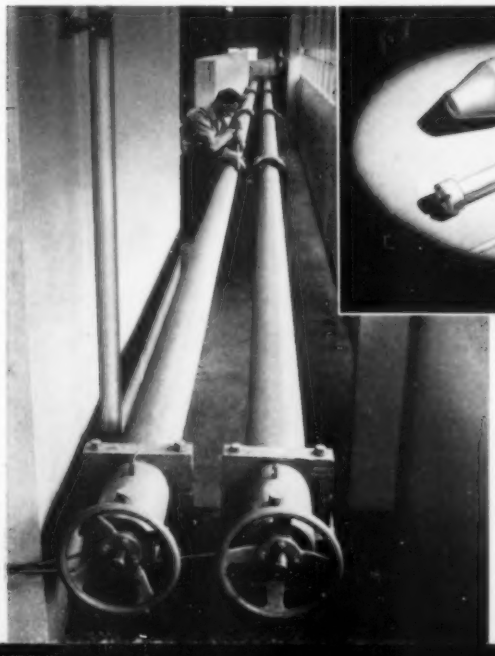
AlSiMag performs at higher temperatures . . . withstands greater thermal shock . . . is stronger, more durable . . . permanently rigid . . . chemically inert . . . thoroughly dependable! AlSiMag can be fabricated in intricate designs to tolerances that compare favorably with precision metal work. AlSiMag will not rust, corrode or deteriorate with time. AlSiMag is the product of fifty-five years of specialized experience plus the finest production equipment . . . high speed presses, high temperature, continuous-fire kilns . . . every possible facility for the finest possible ceramics. In a wide range of shapes and sizes. Volume production or small quantity lots.

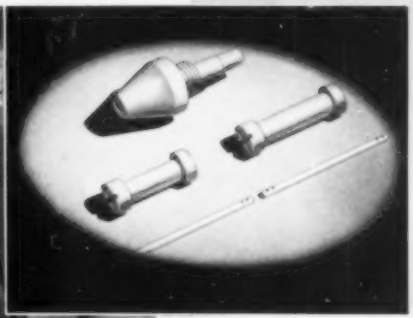
Highly technical applications, however, are not the end of the service story. AlSiMag is entirely practical . . . and vastly superior . . . for everyday industrial use. Economical, too! For any ceramic requirement, your best buy is AlSiMag. Send blueprint or sketch for full details.



Route of transatlantic telephone cable system between Portland and Oban.

Profile of the ocean bottom on which the cable will rest.





Dependable service on the ocean floor . . . not for years but for decades . . . calls for the most careful selection of components. To be economically feasible, the repeater units must have an exceptionally long life, since to raise the cable for replacing just one repeater would be a very costly operation. In the new transatlantic cable, impulses will be relayed by a series of repeaters, built by Western Electric Co., spaced some 40 miles apart. These rugged, low-cost AlSiMag parts are components of these repeaters.

Finished repeaters, with cable leads at each end, are tested at up to 7,500 pounds a square inch in these long cylinders.

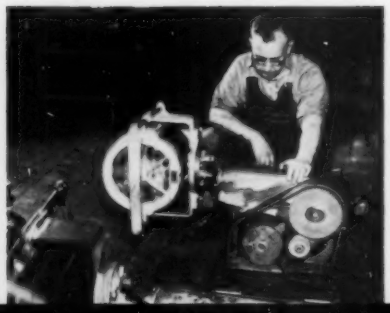
AMERICAN LAVA CORPORATION
CHATTANOOGA 5, TENN.
55TH YEAR OF CERAMIC LEADERSHIP

A subsidiary of Minnesota Mining and Manufacturing Company

AMERICAN LAVA SALES OFFICES IN PRINCIPAL CITIES

20 Case Histories of G-E Motor Benefits

AMERICAN COOLAIR CORP.
"customers like 'no-reoiling' feature"†



RED DEVIL TOOLS
"stands up under severe vibration"

CAMPBELL-HAUSFELD CO.
"makes product easier to sell"

BUCKEYE INCUBATOR CO.
"customers say 'they're dependable'"

TRUFLOW FAN COMPANY
"never had a motor failure"

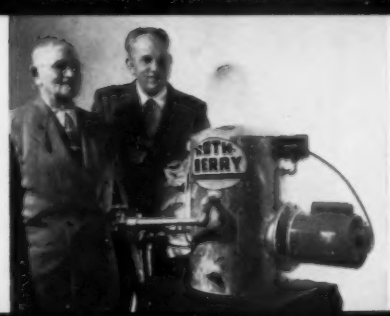
UTILITY APPLIANCE CORP.
"virtually trouble-free service"

BERKELEY PUMP CO.
"lighter weight, modern appearance"

GENERAL WIRE SPRING CO.
"more than adequate power reserve"

W. M. CISSELL MFG. CO.
"easier to handle and install"

PENBERTHY INJECTOR CO.
"allows maximum design flexibility"



A. P. RUTH & CO., INC.
"speeds assembly, saves on shipping"

PERMUTIT COMPANY
"saved $8 per unit"

—HOW MANY APPLY TO YOU?

METALMASTER CORP.
"wide customer acceptance"

MASTER-BILT REFRIG. MFG. CO.
"standardized 100% with G. E."

AMERICAN DUPLEX CO.
"unexcelled durability"

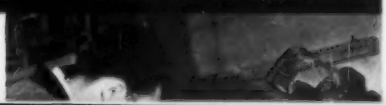
GOLD MEDAL PRODUCTS CO.
"saved 18% in shipping costs"

C. M. SORENSEN CO., INC.
"reduced weight 15%"

ALVEY CONVEYOR MFG. CO.
"all-angle mounting sold us"

MOUNTAIN STATES EQUIP.
"cut weight nearly 10 lbs."

TAIT MANUFACTURING CO.
"neater, more compact"



"YEARS-AHEAD" MOTOR

THESE G-E FHP MOTOR FEATURES ENABLE YOU TO IMPROVE YOUR PRODUCT, YET CUT COSTS

The twenty case histories at left are typical of the profit-building experiences of thousands of manufacturers using General Electric motors. The reason is simple—only G.E. gives you *all* of these outstanding features, combined into a complete line of smaller, lighter motors.

1. SMALLER, LIGHTER DESIGN—The trend to modern appearance and portability is reflected in this General Electric motor. It's 40% smaller, 50% lighter than old-style designs.

2. MYLAR* POLYESTER FILM INSULATION—It has over 35 times more moisture resistance, 8 times more dielectric strength than ordinary paper insulation.

3. ALL-ANGLE OPERATION—General Electric's all-angle lubrication system gives you positive lubrication regardless of mounting position. As a result, you can often avoid the higher cost of "special" motors.

4. EASY CONNECTION—A speed nut welded inside the motor shell permits fast, easy connection of conduit fitting.

5. MOUNTING VERSATILITY—This G-E motor, whether resilient or solid-base, can be rotated inside its cradle to obtain complete mounting versatility. The cradle may also be removed entirely to meet your design needs.

6. DOUBLE LUBRICATION LIFE—The General Electric combination of a larger oil capacity (50% more than old style designs), and an efficient oil retention system means minimum motor maintenance for you.

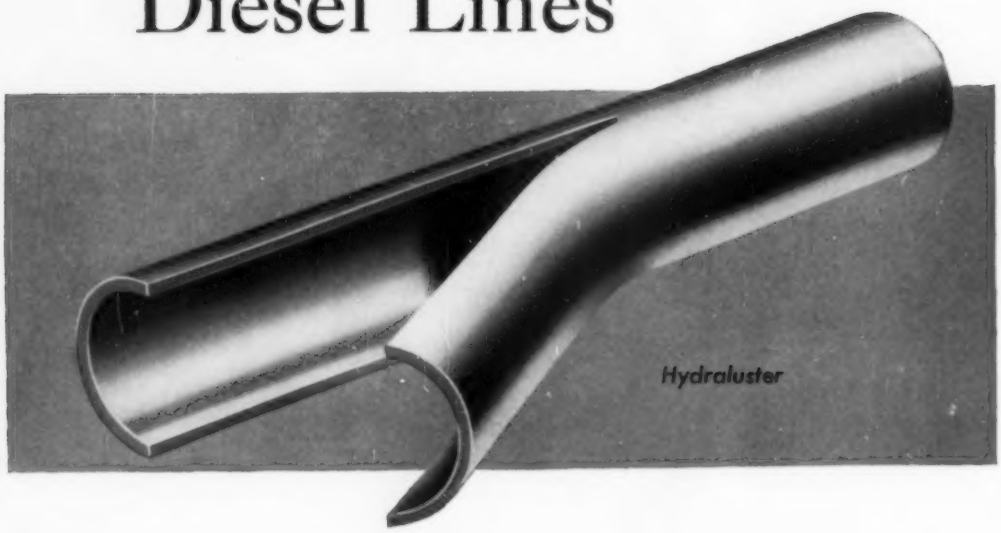
Thousands of manufacturers have already used millions of these "Years-ahead" G-E motors. Why not evalute your own motor savings in terms of these G-E motor benefits?

For more information, contact your nearby G-E Apparatus Sales Office, or write Section 702-29, General Electric Co., Schenectady, New York.

* DuPont registered trademark.
†Feature of G-E summer cooling fan motors.

GENERAL ELECTRIC

A New Material for Hydraulic and Diesel Lines



T. L. PARKER Vice President
Columbia Steel and Shafting Co.

Interior scaling and flow resistance—magnified by the introduction of the newer, high speed hydraulic fluids—point up a problem that is not entirely new to designers and engineers in the hydraulic and diesel fields. Oxidation and scale adhering to tubing walls can restrict flow in fluid systems, causing pressure changes and forcing the system to function at a substandard rate of efficiency. This same scale, loose and circulating, of course causes additional damage and premature deterioration of valves and pumps. The introduction of any other type of foreign matter or dirt, during or after manufacture, would have the same general effect.

A new tubing, now available in commercial quantities, is providing a logical solution to the problem. Marketed under the name of Summerill HYDRALUSTER, it has an exceptionally smooth, bright and *clean surface on both interior and exterior walls.* Produced by an annealing process that regulates the cooling cycle as meticulously as the heating phase, Hydraluster is highly resistant to oxidation, and the smooth wall finish is not conducive to dirt adherence. Initially clean, the tubing is shipped fully protected by special preservatives, and it can be provided in individually capped lengths. The preservatives are easily removed with good grades of commercial solvent.

An interesting by-product of the silver-bright finish is the sales appeal it adds to OEM equipment. Hydraluster has the inherent strength and exceptionally fine working properties of steel, and is available at standard hydraulic tubing prices.

SAMPLES and SPECIFICATIONS: While supplies last, we'll gladly send you a sample of HYDRALUSTER. Your name, on company stationery, will bring specifications, descriptive literature and the sample by return mail.

Summerill **Tubing Company Division-Columbia Steel & Shafting Co.**

PITTSBURGH 30, PA. DEPT. NO. 1-11

District Offices: Buffalo • Chattanooga • Cleveland • Dayton • Hartford • Philadelphia • Pittsburgh • Milwaukee • Chicago

Q • What constitutes a dependable • source of metal powder parts?

A:

If the source is strong in experience, ability and good judgment —like Moraine Products—it cannot miss being dependable.

Moraine Products has the experience gained from the production of hundreds of millions of metal powder parts in an infinite variety of shapes and sizes. Moraine Products has the engineering and metallurgical ability to design parts for specific applications so that they can be produced most economically—usually in one press operation. And, finally, Moraine Products has the good judgment to recognize the limitations as well as the advantages of metal powder in each proposed application.

When we accept an assignment to make a part from metal powder, it is only after thorough conviction that our material and our process are best suited for the job the part will ultimately be expected to perform for the customer.

Moraine Products also produces: Moraine Power Brakes—Delco hydraulic brake fluids, brake assemblies, master cylinders, wheel cylinders, and parts—Moraine friction materials —Moraine-400 and M-100 automotive engine bearings—self-lubricating bearings and porous metal filters—rolled bronze and bi-metal bushings.

Another General Motors Value

Moraine Products

Division of General Motors, Dayton, Ohio

A SHORT CUT TO A FINISHED PRODUCT

SAVE YOURSELF TIME AND TOOL CHARGES

with Anaconda multiple-plunger press products—in a wide choice of metals

If you need parts like these in quantity, The American Brass Company can save you time and money. Through its specialized experience—and thousands of stock tools—it may save tool charges, too.

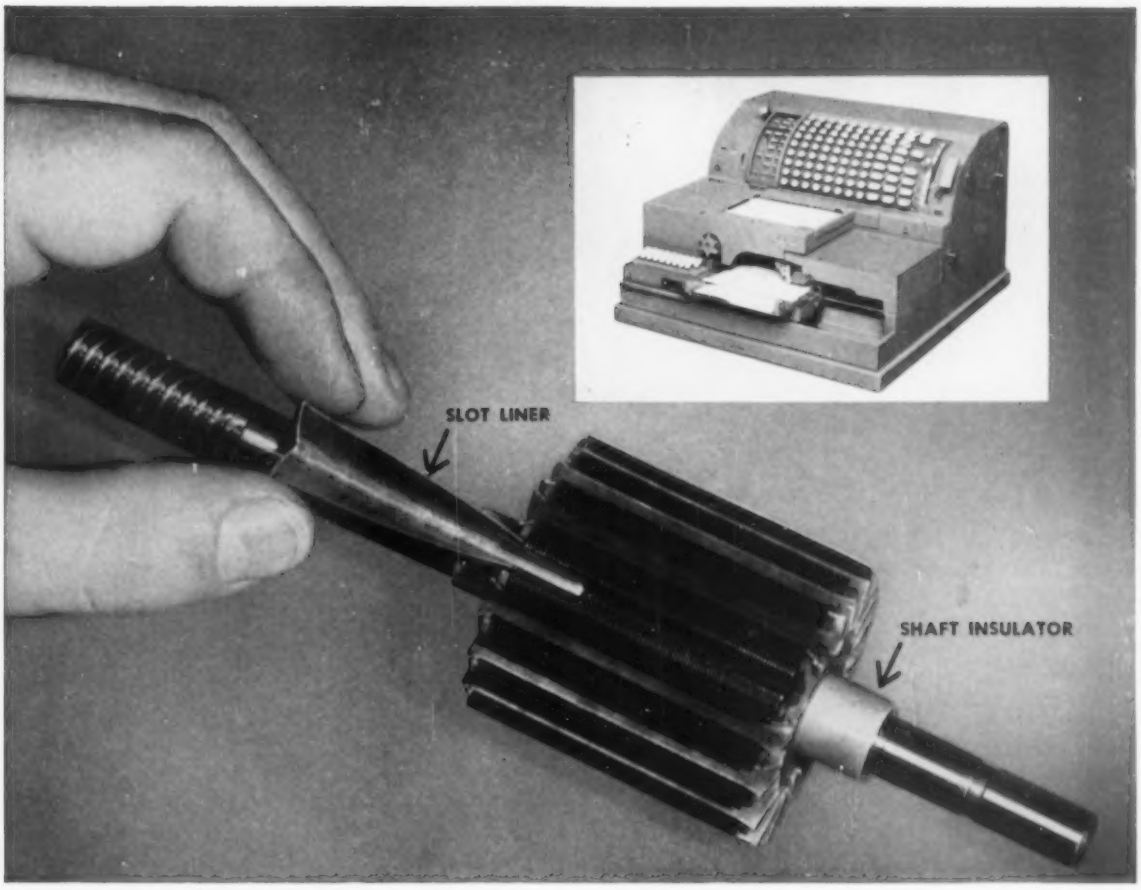
Ferrules, grommets, eyelets, deep-drawn cups and shells, and thousands of other intricate, close-tolerance parts made from strip metal are everyday business. American Brass Company design engineers and toolmakers have earned an enviable reputation for cutting costs and performing the almost impossible in design and production.

Your choice of metal: Such fabricated products can be furnished in copper, brass, bronze, nickel silver, nickel, iron, steel, stainless steel, and aluminum – in a wide variety of finishes.

Standard products: For a selection of more than 1000 eyelets of common sizes and styles, as well as eyelets kept in stock for immediate shipment, write for Catalog BG-1.

Special products: Just send a sample, drawing, or description, together with the quantity you need, the metal to be used, and other pertinent information. Address: The American Brass Company, Waterbury Brass Goods Division, Waterbury 20, Conn. 5588

ANACONDA®
MULTIPLE-PLUNGER PRESS PRODUCTS



National Cash Register Co. reports:

Motor insulation with MYLAR® provides improved performance, longer life

"We use Du Pont 'Mylar' for insulation in our business-machine motors because of high dielectric strength and resistance to degradation through heat and age." This is the report of the National Cash Register Company, Dayton, Ohio, which uses "Mylar" laminated to rag paper for the armature slot liner and shaft insulator. This successful application of "Mylar"* has effectively increased service life of the motors, especially in areas where high humidities have created problems in insulation resistance.

Since "Mylar" is the strongest of all plastic films, thinner gauges are possible. This makes for reduced cost, weight and space. Laminates with "Mylar" have good forming and cuffing characteristics for ease of application.

Whether you make heavy-duty motors or tiny capacitors, you may be able to improve performance and increase the over-all value of your product by using "Mylar." For more information on this versatile film, mail the coupon below.

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...THROUGH CHEMISTRY

DU PONT
MYLAR®
POLYESTER FILM

*MYLAR *is Du Pont's registered trademark for its brand of polyester film.*
In Canada, "Mylar" is sold by the Du Pont Company of Canada Limited, Films Div., P.O. Box 660, Montreal, Quebec.

E. I. du Pont de Nemours & Co. (Inc.)
Film Dept., Room P 8. Nemours Bldg., Wilmington 98, Del.

Please send your booklet on motors insulated with "Mylar" polyester film (MB-5).

We are interested in "Mylar" for_____

Name_____

Firm_____

Address_____

City_____ State_____

HOW USS "T-1" STEEL IMPROVES THESE PRODUCTS...

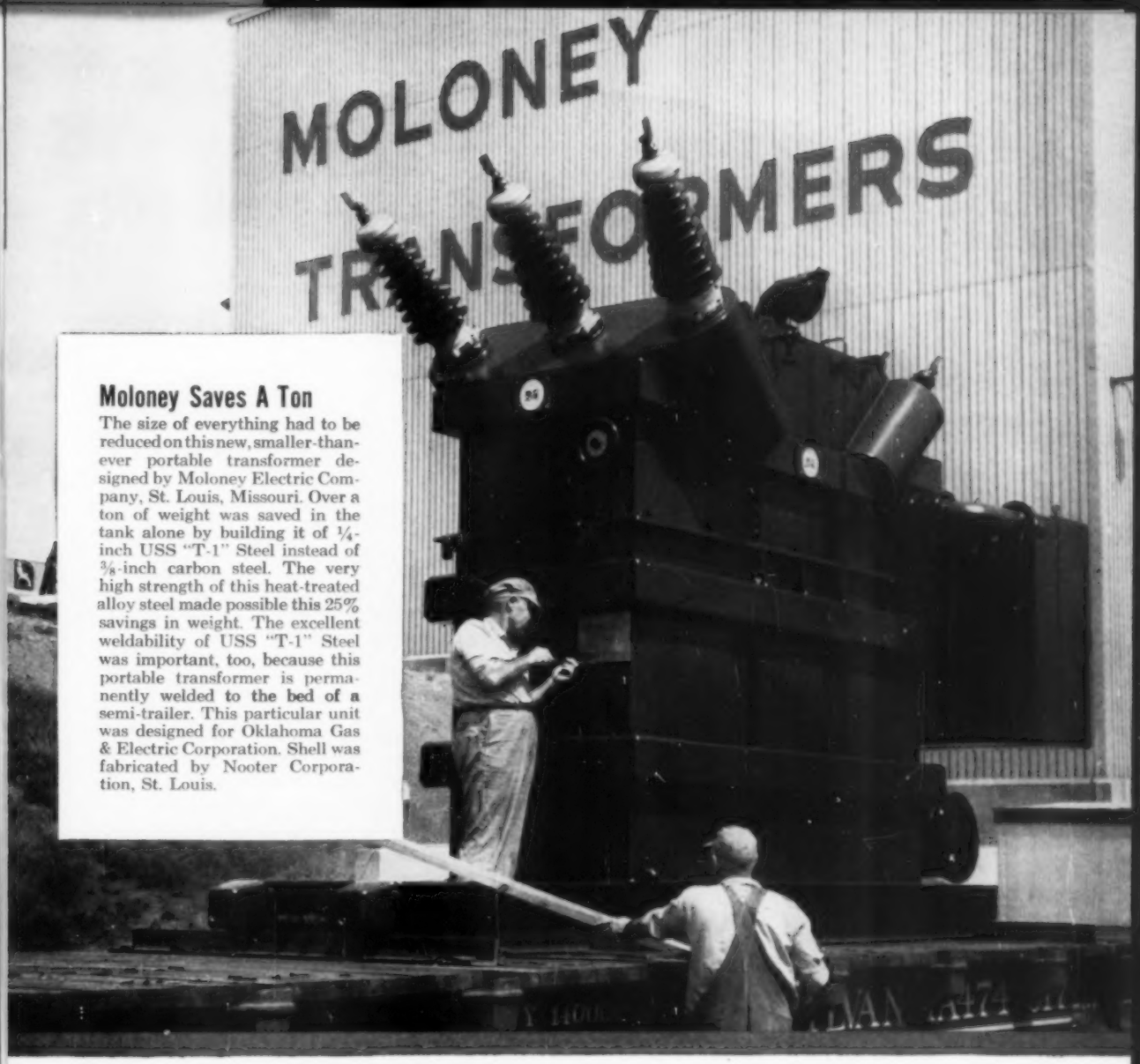
Lower-Cost Dirt

This mammoth coal stripping machine scoops out 2000 yds. of overburden an hour, cuts the cost of stripping coal that lies under 50 to 80 ft. of overburden. Its 22-ft. wheel carries eight buckets, each 4 ft. wide, with lips of 2½-inch USS "T-1" Steel. USS "T-1" Steel has the strength and toughness to scrape through shale, rock, mud, and ram into ton-and-a-half boulders day in and day out. In addition, it is weldable in the field, costs less than other steels that could be used—and outlasts them. This wheel excavator was designed by United Electric Coal Companies, Chicago, for their own use.

Shucks, hay fodder, corn cobs, and grains are extremely abrasive when sucked out of a hammermill at high speed. And the blades of the fan that does the sucking must withstand the abrasion and be weldable. Myers-Sherman Company, Streator, Illinois, manufacturers of industrial hammermills, switched to USS "T-1" Steel and saved $7 on fabrication of each fan.

Heavier Loads, More Production

Mack Welding Company, Duluth, Minnesota, has used "T-1" Steel to increase the durability and at the same time reduce the weight of its Orange Peel Type, Four Tine Pulpwood Grapples. With these new, lightweight grapples, crane operators can handle increased payloads with present cranes. As a result, production can be increased as much as 40 percent.



Moloney Saves A Ton

The size of everything had to be reduced on this new, smaller-than-ever portable transformer designed by Moloney Electric Company, St. Louis, Missouri. Over a ton of weight was saved in the tank alone by building it of ¼-inch USS "T-1" Steel instead of ⅜-inch carbon steel. The very high strength of this heat-treated alloy steel made possible this 25% savings in weight. The excellent weldability of USS "T-1" Steel was important, too, because this portable transformer is permanently welded to the bed of a semi-trailer. This particular unit was designed for Oklahoma Gas & Electric Corporation. Shell was fabricated by Nooter Corporation, St. Louis.

HOW IT CAN HELP YOU

USS "T-1" Steel, with its high minimum yield strength of 90,000 psi and its minimum tensile strength of 105,000 psi, can help you design or build lighter-weight equipment that will last longer. Its unusual toughness can help you design or build equipment capable of taking severe impact and abuse at sub-zero temperatures. Its excellent weldability can help you cut the cost of fabricating high strength parts, and reduce repair and maintenance expense. Its good creep rupture strength can help you put more durability in equipment that operates at temperatures as high as 900 degrees F.

Somewhere in your operation, versatile USS "T-1" Steel can help you. Write, wire, or phone United States Steel, Room 5396, Pittsburgh 30, Pa.

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UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST · UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS "T-1" CONSTRUCTIONAL ALLOY STEEL

USS

SEE The United States Steel Hour. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

UNITED STATES STEEL

New equipment, expanded departments, added technical personnel and increased productivity all help to make Long your ideal "production partner."

But you'll discover Long's real plus factors in our management-engineering team. Its talent for creating high quality products with economical design and volume manufacturing advantages is your biggest profit potential.

DOUBLE-PLATE CLUTCHES BOOST TORQUE CAPACITY

Available in many sizes, Long's double-plate clutches with high-gripping action anticipate advancing horsepower and torque requirements in trucks, tractors, off-highway vehicles and industrial applications. Like Long single-plate clutches, these heavy-duty production models are individually tailored by our engineers to performance requirements of any size or type of vehicle.

Long-innovated clutch features that have set industry standards include dry discs, variable springing, high-ventilation triangular covers, spring vibration dampers and cushion segments. Ask us to recommend an application conforming to your specifications.

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PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA
ON THESE VERSATILE ENGINEERING MATERIALS
"ZYTEL," "ALATHON," "TEFLON," "LUCITE."

Moving parts made of ZYTEL® nylon resin are economical and durable

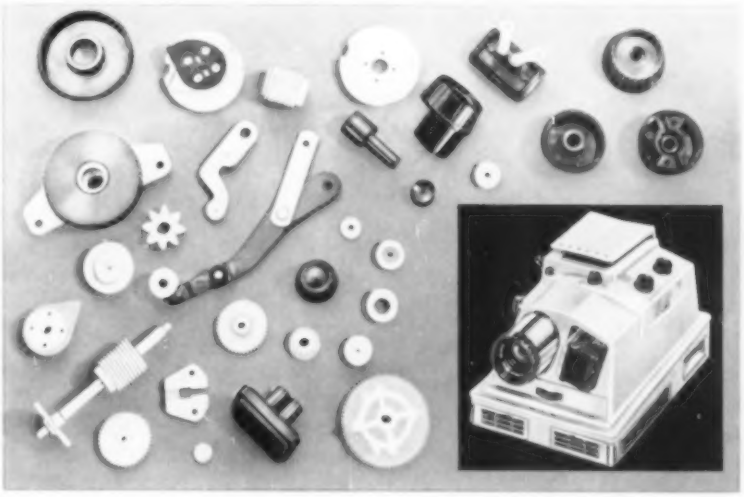
Du Pont ALATHON® provides long life for scrubber handling hydrofluoric acid

THE EXCELLENT chemical resistance, high impact strength, and the low-temperature flexibility of Du Pont ALATHON polyethylene resin make it an outstanding material for use in many types of chemical processing equipment.

The chemical scrubber shown below, fabricated of Du Pont ALATHON polyethylene resin, is virtually maintenance free. It measures four feet in diameter, is five feet high, and has a gas flow of 2500 cfm at 1½″ psi. This scrubber is used in contact with hydrofluoric acid and fluorides.

ALATHON polyethylene resin withstands these corrosive conditions. It is light in weight, nontoxic, and virtually odorless and tasteless. Low temperatures will not affect the strength and flexibility of ALATHON. For more information on this material, clip the coupon.

Manufactured by American Agile Corporation, Cleveland, Ohio, this chemical scrubber is used in contact with hydrofluoric acid, and fluorides.



The "888", a new slide-film projector manufactured by the Revere Camera Company, Chicago, Illinois, features automatic operation. Thirty-one parts made of Du Pont ZYTEL nylon resin are used in the construction of this quality projector.

THIRTY-ONE parts made of Du Pont ZYTEL nylon resin are used in a new 35mm slide-film projector, the "888", manufactured by the Revere Camera Company. A new model Revere automatic slide projector, the "888-D", utilizes parts of ZYTEL also, and features a preconditioning chamber, illumination coverage for 1½″ x 1½″ transparencies, and coated optics throughout. Because ZYTEL is specified, the intricately shaped precision parts are mass-produced by the injection-molding process. Such molded parts generally require no finishing. Substantial savings in production costs result. Parts of ZYTEL are long wearing and durable. The low coefficient of friction of ZYTEL provides smooth operation and often eliminates the need for lubricants.

Useful combination of properties

Because of its useful combination of properties, ZYTEL nylon resin is used for many types of mechanical parts—bushings and bearings, gears, cams, rollers, worm gears, for example. Parts made of ZYTEL have outstanding toughness, abrasion-resistance, strength in thin sections, lightness in weight, and chemical resistance. ZYTEL nylon resin is a versatile material which design engineers find helpful in solving many of their problems.

Get more information

For more information on how you may incorporate ZYTEL in your own product, mail the coupon on the reverse side.

OVER

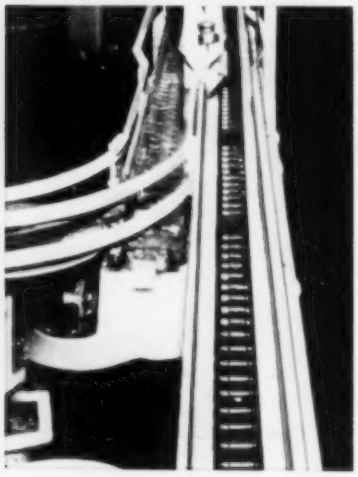
DU PONT

PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA
ON THESE VERSATILE ENGINEERING MATERIALS
"ZYTEL," "ALATHON," "TEFLON," "LUCITE."

Conveyor wear strips of ZYTEL® nylon resin require no lubrication

A COMBINATION of impact resistance, toughness, resilience, and excellent bearing characteristics makes Du Pont ZYTEL nylon resin



an outstanding material for use in demanding mechanical applications.

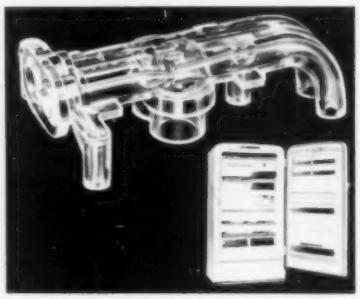
The Peter Hand Brewery Company of Chicago has solved several difficult bottling problems by installing conveyor line wear strips made of ZYTEL. Because of the low coefficient of friction of ZYTEL, these wear strips are not lubricated. Wear strips made of ZYTEL give smoother performance with reduced power requirements, effecting start-up of a full line without danger of spilled containers. Neither steam sterilization nor long wear has impaired the efficiency of wear strips made of ZYTEL. Easily installed over existing conveyor ways, wear strips made of ZYTEL can be used with chains of ZYTEL or metal. (*"Nylite" wear strips manufactured by Fenco, Inc., Chicago, Illinois.*)

For full property and application data on ZYTEL nylon resin, use the coupon.

Complex venturi valve molded of sparkling, durable LUCITE®

THE HEART of the automatic twin juice fountain is a dual venturi valve, developed and manufactured by The Dole Valve Company of Chicago. The venturi, made of Du Pont LUCITE, operates on water pressures from 15 to 125 pounds, drawing just the right amount of concentrated fruit juice to provide the correct 3 to 1 mixture, blended and aerated.

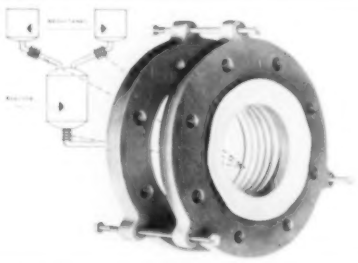
LUCITE acrylic resin was selected for this application because of its moldability, and resistance to corrosion by fruit acids. Had this complicated valve been produced in metal, it would have required many costly machining and assembly operations. With LUCITE, the entire unit is produced in a single operation, affecting a substantial reduction in cost of production for this part. The transparency of LUCITE makes it easy to keep the spout clean.



Twin juice fountain of LUCITE mixes and dispenses fruit juices as needed. Complex unit is injection molded in a single operation by Chicago Molded Products Corporation, Chicago, Ill., for The Dole Valve Co.

LUCITE may offer many design advantages in certain of your industrial applications, especially where visibility is important. Its transparency, strength, impact resistance and moldability make LUCITE suitable for rugged applications.

Send for further property and application data on LUCITE. See how LUCITE can provide the answer to your next design problem.



Expansion joint bellows of TEFLON® tetrafluoroethylene resin is flexible, yet strong. Its flexibility compensates for misalignment between connections in pipes joining tanks, pumps, or reactors . . . absorbs vibration and allows equipment parts to expand and contract safely. TEFLON has a service temperature ranging from −450 F. to 500 F.

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Room 108, Du Pont Building, Wilmington 98, Delaware.
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Please send me more information on the Du Pont engineering materials checked: ☐ *ZYTEL;* ☐ *ALATHON;* ☐ *TEFLON;* ☐ *LUCITE. I am interested in evaluating these materials for:*

NAME _____ POSITION _____

COMPANY _____

STREET _____

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For complete details that will help you further evaluate these Du Pont engineering materials for use in your product development programs, mail the coupon at the left. Specific property and application data will be sent to you.

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Improved All-Purpose No. N378 "Whitney" Tracing Cloth

- Resists Liquids and Solvents!
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Two Improved Special-Purpose Cloths

No. 370 "McKINLEY"

Primarily designed for pencil, this modern cloth stands unequalled by any product of its type for durability and reproduction performance! It readily takes pencil hardness up to 8H. Blue or white.

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Exclusively designed for ink, this new and better cloth is unmatched for its superb acceptance of ink, maximum contrast in printing, top reproduction speed. Blue only.

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Here it is! The truly modern and wonderfully improved all-purpose tracing and drawing cloth that you can use *profitably* for every job in your drafting room!

This remarkable cloth just can't be damaged by perspiration, spilled drinks, or repeated use of regular drafting room solvents. It readily accepts pencil *up to 9H hardness*, can also be used with ink. Its completely clear body, high translucency, and high permanence assure sharp, good-looking tracings and drawings that produce fine prints, even after long periods of storage.

No tracing or drawing medium could be more economical or practical! You get good results every time—minimize the constant danger of damage to costly drawings. You speed draftsmen's work, get faster reproduction. You can use this versatile cloth for every tracing and drawing job in your drafting room, simplify and save on purchasing, stocking, and inventory of materials.

Try this all-modern, all-purpose tracing and drawing medium. Here is the smallest cost going into a tracing or drawing, but one of the most important. Send today for your free 8½ x 11-inch sample sheet. Blue or white.

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☐ All-purpose "Whitney" No. N378 ☐ "McKinley" No. 370
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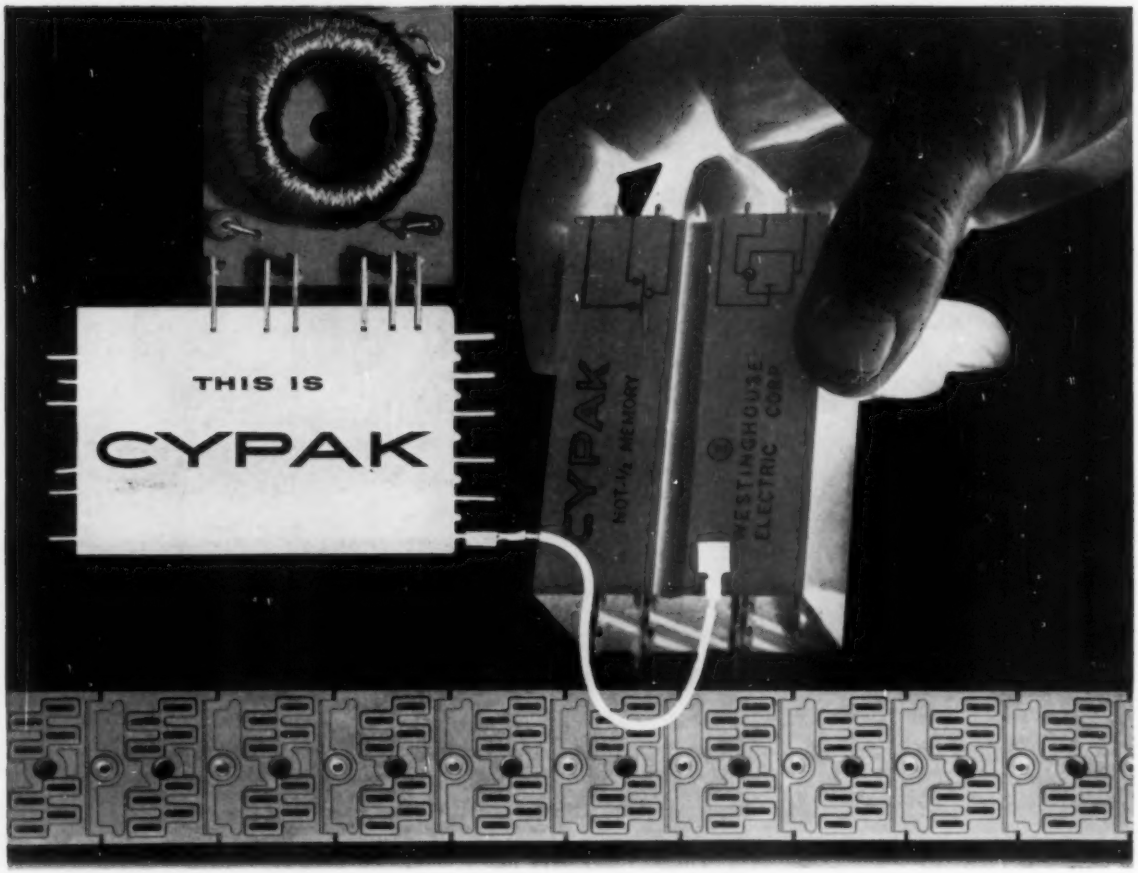

for industrial control 15 times more reliable

With CYPAK* control you can introduce a whole new concept of reliability for industrial systems. Unlike the mechanical relay, CYPAK has *no* moving parts. While twenty million open-close cycles is usually the maximum life of a mechanical relay, CYPAK systems can handle that many cycles in days, without a trace of fatigue. Down time due to wear, corrosion, or jamming no longer throws a block to expanding control system responsibility.

One reason for CYPAK dependability is Westinghouse Hipernik* V magnetic steel. In toroidal coils, this high-grade steel produces sharp current amplification to parallel the mechanical relay step function. These important magnetic characteristics are completely protected by sealing each CYPAK component panel in a solid plastic block.

Look into all the new opportunities in CYPAK by calling your Westinghouse sales engineer today. J-01003

*Trademark

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WITH CHASE® S-19 PROCESS BRASS STRIP

CHASE S-19 BRASS is *unique* through and through! Special manufacturing techniques give it an exceedingly fine, uniform grain structure, and it has unusually high ductility. It is adaptable for forming or even relatively deep-drawing articles which are surprisingly scratch and dent resistant. They will buff or polish more easily, too.

It takes precise Chase quality control at the mill to produce the superb finish, stiffness and formability of Chase S-19 brass—*yet it costs you no more than commercial soft brass!* Call in a Chase representative for all the facts, today!

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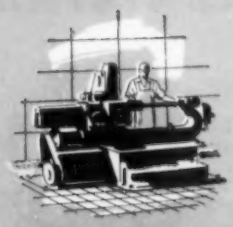
A complete line of Roller Bearings . . .

For every field of transportation and industry

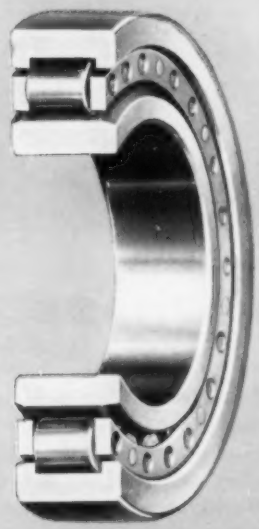


Job-tailored in a wide range of sizes to fit your specific needs

Aircraft? Automobiles? Earth-moving or farm equipment? *Whatever* you make, if your product uses straight or tapered roller bearings, Bower can meet your specifications *exactly*. For dependable Bower bearings are virtually custom-built to the job . . . engineered and sized to match any requirement.

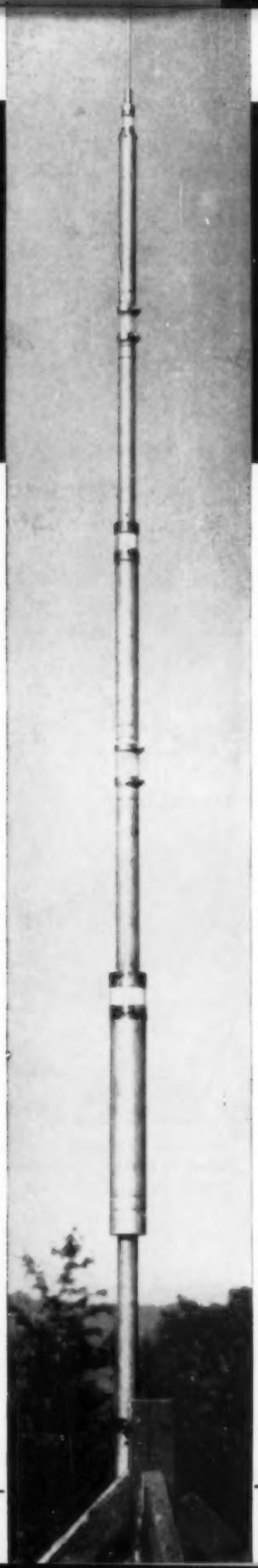
Important, too, are exclusive Bower design features that assure long life, top performance, *less maintenance*. And when you specify Bower bearings you can always be certain of the highest quality materials and workmanship. These reasons, of course, are why Bower straight, tapered and journal roller bearings are used by leading manufacturers everywhere—for any application.

Let a Bower engineer give you full details of the complete Bower line. Call him in while your product is still in the design stage.



BOWER ROLLER BEARINGS

BOWER ROLLER BEARING DIVISION • *FEDERAL-MOGUL-BOWER BEARINGS, INC., DETROIT 14, MICH.*



Mast of
SHELBY SEAMLESS TUBING
(USS STAINLESS STEEL)
provides high strength and corrosion resistance for coaxial antenna

The Type 3006 Coaxial Colinear Antenna*, consisting of three half-wave vertical dipoles arranged colinearly and operating on a frequency range of 152-176 MC, is especially suitable for patrol car broadcasting. The three vertically arranged dipoles exhibit a gain of 5 to 6 db over a standard single dipole, and produce a low angle of radiation with equal radiation in all directions.

This 13½-foot, 40-pound antenna is supported by a mast made of Shelby Seamless Tubing (USS Stainless Steel) running through its center. In addition to possessing the tensile strength to withstand 100-mile-per-hour winds, this stainless supporting mast has high corrosion resistance—will not flake from oxidation and cause short circuits.

In such critical applications where superior strength, uniformity, dimensional accuracy and corrosion resistance are needed, Shelby Seamless Tubing of USS Stainless Steel is consistently chosen to meet the requirements. Shelby Seamless Tubing, available in a wide range of diameters, wall thicknesses, various shapes and steel analyses, is produced to exacting standards by the world's largest manufacturer of tubular steel products. If you wish, our engineers will make a study of your requirements, and will help you apply Shelby Seamless Steel Tubing to your specifications.

*Name of manufacturer on request.

NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)

COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS · UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS **SHELBY SEAMLESS MECHANICAL TUBING**

UNITED STATES STEEL

are your steam traps ready...

for peak demand in the winter months?

Don't risk the possibility of equipment failure . . . even freezeups. Check your steam traps right now, before the first frost.
Drain them, take them apart, make sure that all parts are working and free from corrosion.

Of course, if you already use Nicholson steam traps, you're in luck. They completely drain themselves when cold. And with just three parts, they're the simplest traps to look after when a checkup is in order.

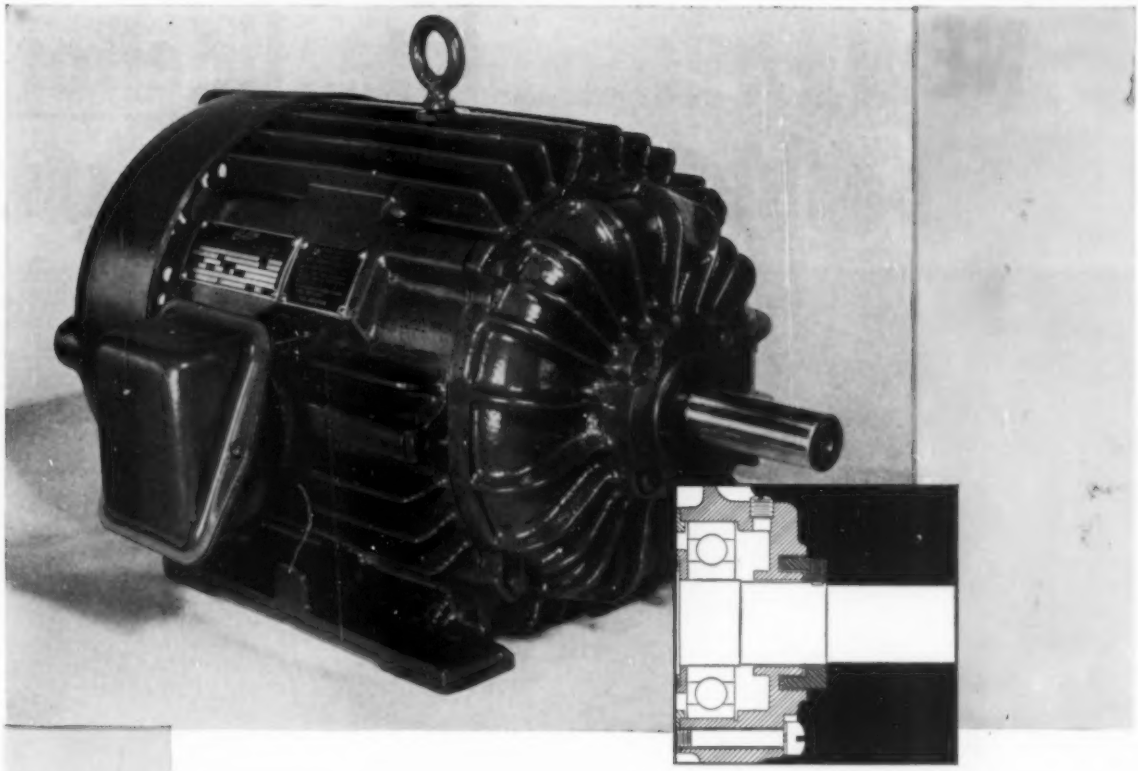
But regardless of what traps you use at the present time, we'll be glad to help you with any problem you may run into in getting your equipment in shape.

Write, today, for your copy of new Bulletin 10-55—for detailed information.

NICHOLSON

W. H. NICHOLSON and Company

TRAPS • VALVES • FLOATS • METAL PARTITIONS
LAUNDRY, DRY CLEANING AND PRESSING MACHINERY
14 OREGON STREET, WILKES-BARRE, PA. • SALES AND ENGINEERING OFFICES IN 98 PRINCIPAL CITIES



Securely sealed for low maintenance —

Century

TOTALLY ENCLOSED FAN COOLED MOTORS

When motor maintenance goes down, production goes up. Century TEFC Motor *protects itself* from dust, grit, chemical fumes, moisture. Shaft openings at each end are labyrinth-sealed, and there is a precision clearance between metal seal and bearing bracket.

Outside, a hose or whisk broom quickly cleans it. External fan forces jets of cooling air across the frame. Inside, vital motor parts are completely sealed off from injurious atmosphere. Factory lubrication of bearings is adequate for several years' service under normal conditions; however, whenever required bearings may be relubricated through grease plugs.

For full facts on your specific application, call the Century District Office or Authorized Distributor nearest you.

CENTURY . . . building TEFC Motors for 25 years

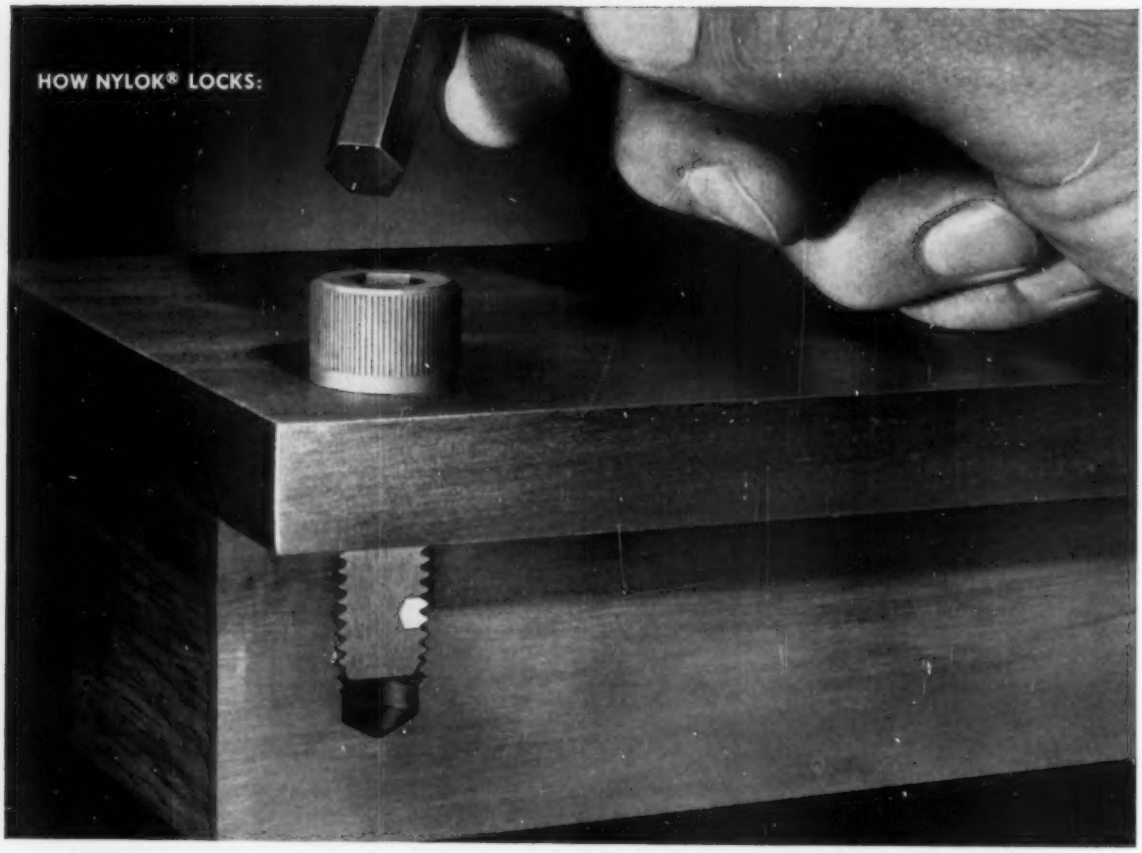
CE-66

Performance-Rated©
MOTORS
1/20 to 400 H.P.

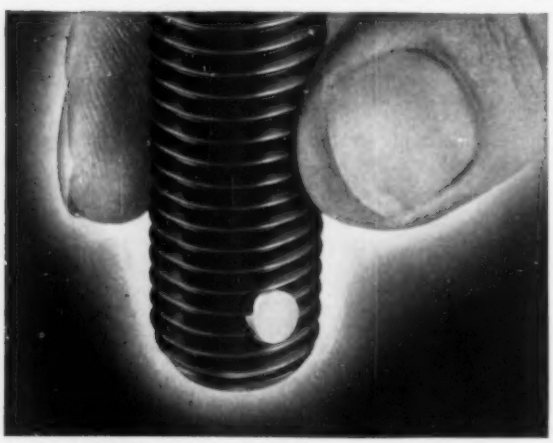
CENTURY ELECTRIC COMPANY

1806 Pine Street • St. Louis 3, Missouri • *Offices and Stock Points in Principal Cities*

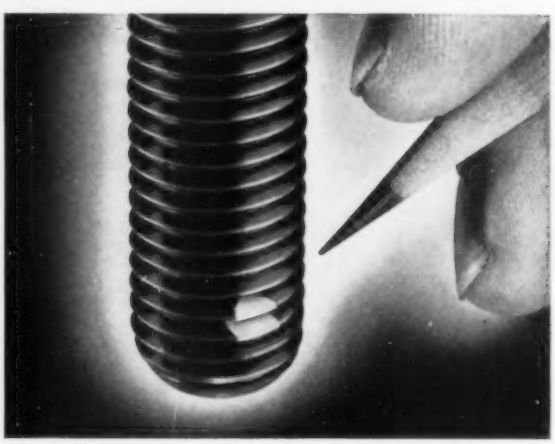
NEW—a complete line of socket screw products



LOCKED! The tough, resilient nylon pellet keys itself into the mating threads. It forces threads together, and locks the screw securely.



BEFORE ASSEMBLY. The nylon pellet projects slightly beyond male threads. When assembled, female threads will be impressed into it. Pellet locks effectively whether the screw is seated or not.



AFTER REMOVAL. "Plastic memory" of pellet has expanded impressed threads to greater diameter than screw threads. Screw can be used repeatedly. In use, "memory" keeps threads tightly locked.

self-locking UNBRAKO that won't work loose

They simplify design and save production time

UNBRAKO socket screws are now available embodying the Nylok* self-locking principle. Nylok provides a truly practical new solution to the problem of making screws self-locking.

An UNBRAKO screw with Nylok is a single self-locking unit. No auxiliary locking devices are needed. Just thread the UNBRAKO into any tapped hole. *Seated or not*, it locks positively wherever wrenching stops. The tough, resilient nylon pellet forces mating threads together and holds tight. The screw will not shake loose.

You save production time when you build products with self-locking UNBRAKOS. And you get greater simplicity in design with less bulk and weight. The number of parts you must assemble to achieve full locking action is reduced to the absolute minimum. Lockwashers under screw heads are no longer necessary. Costly wiring of cross drilled heads is eliminated. So are cotter pins and complex multiple set screw installations.

Self-locking UNBRAKOS are completely reusable. They have uniform locking and installation torques—with no galling or seizing on mating threads. They successfully withstand temperatures from —70° to 250°F. And, on properly seated screws, the pellet acts as a liquid seal.

Self-locking UNBRAKO socket screws come in a complete range of standard sizes and materials. See your authorized industrial distributor. Technical data and specifications are detailed in Bulletin 2193. Write us for your copy today. Unbrako Socket Screw Division, STANDARD PRESSED STEEL CO., Jenkintown 28, Pa.

**T.M. Reg. U.S. Pat. Off., The Nylok Corporation*

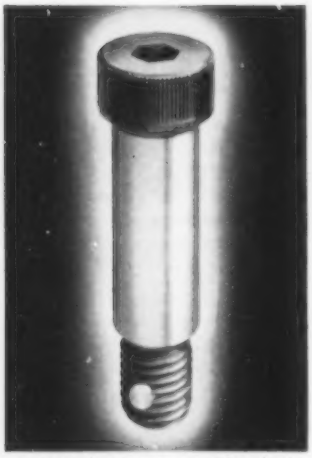
UNBRAKO SOCKET SCREW DIVISION

STANDARD PRESSED STEEL CO.

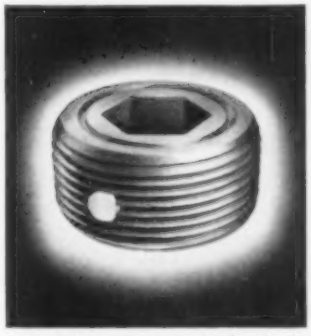
SPS

JENKINTOWN PENNSYLVANIA

Socket head cap screws. Standard sizes # 6 to 1 in.



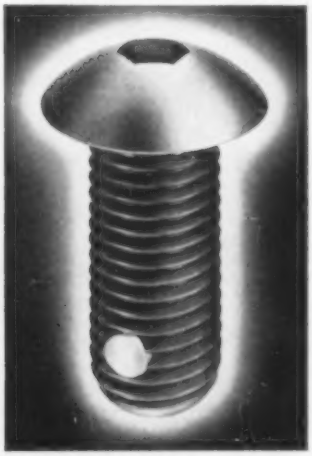
Socket shoulder screws. Standard sizes ¼ to ¾ in.



Socket pressure plugs. Standard sizes ⅛ to 1¼ in.

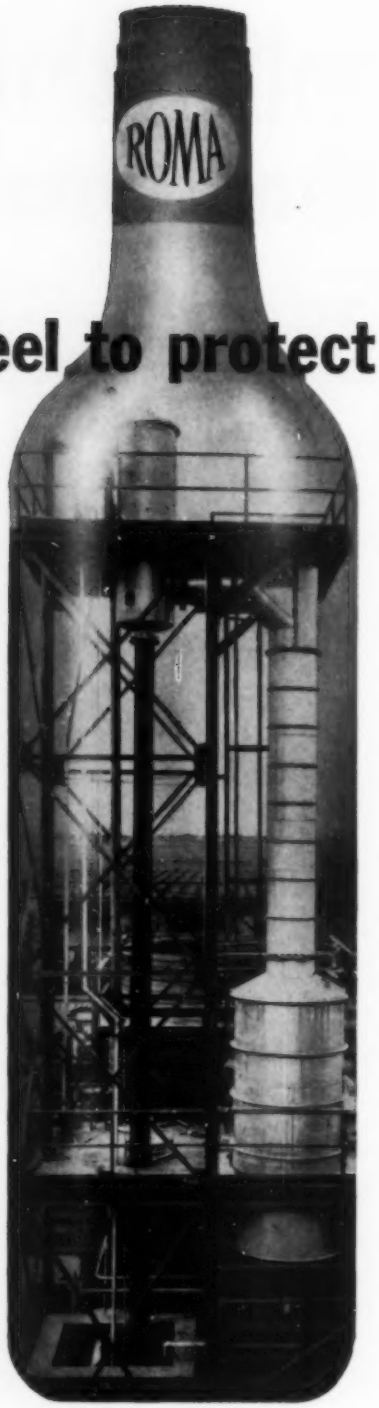
Socket set screws. All standard point types. Standard sizes # 8 to 1 in.

Flat head socket screws. Standard sizes # 8 to ¾ in.



Button head socket screws. Standard sizes # 6 to ⅜ in.

Designed with stainless steel to protect product purity



America's largest winery has specified stainless steel in new equipment, as a regular policy to replace old and obsolete installations known to be sources of metal pick-up. This user, The Roma Wine Company, finds prevention far better than the cure. And less costly, too!

Resist Corrosion

Chromium-nickel stainless steels resist attack by chemicals and atmospheres over wide ranges of concentrations, pressures and temperatures.

Prevents Contamination

The inherently hard, smooth surfaces of these austenitic chromium-nickel steels make poor harbors for bacteria or other contaminants.

Easy to Clean

Also, users find stainless steel equipment easy to clean and to *keep hygienically* clean as well as attractive in appearance.

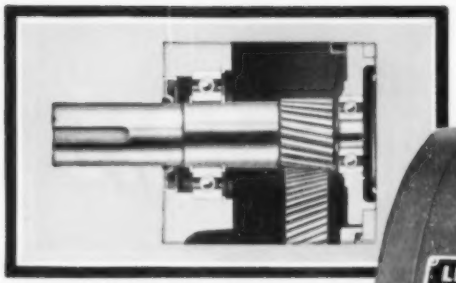
New Stainless Steel Booklet Available

Write for a copy of "Stainless Steel in Product Design." Yours for the asking . . . it tells where and how to use stainless, how to design for lower cost, and other ways to give your products an edge on competition. Write for it now.

Roma Wine Company, a division of Schenley Industries, Inc., makes grape juice concentrate at the rate of 600 gallons per hour in the vacuum pans (above) of chromium-nickel stainless steel. Typical of other stainless equipment used for safeguarding purity of Roma products are pasteurizers, heat exchangers, centrifugal pumps, agitator tanks and wine coolers. All of austenitic chromium-nickel stainless steel.

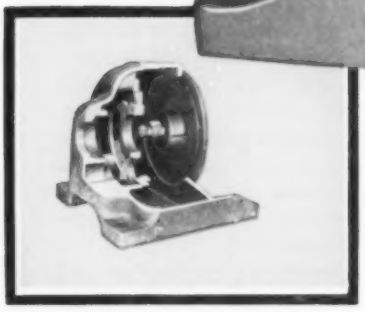
INCO TRADE MARK **THE INTERNATIONAL NICKEL COMPANY, INC.** 67 Wall Street New York 5, N.Y.

From Link-Belt . . . NEW, precision-made In-Line Helical Gear Drives

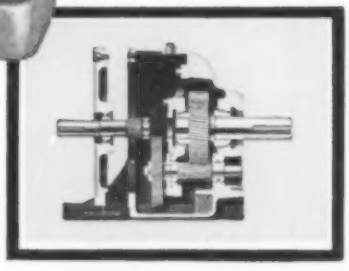


RIGIDITY of high speed shaft and pinion is provided by straddle-mounting—of extreme importance in coping with shock, reversing and heavy loads.

HARDENED GEARS are produced on modern hobbers and are accurately shaved. This provides the ultimate in gear performance.



OIL-TIGHT DESIGN is provided by one-piece, close-grained cast iron housing with effective oil seals.



ONE LOW-SPEED GEAR SET per drive size and maximum accessibility of all operating parts simplifies maintenance.

WHEREVER you need dependable speed reduction up to 118 hp . . . and strength and long life are major factors — new Link-Belt In-Line Helical Gear Drives are specifically equipped for the job. In their smooth, corrosion-resistant, husky cast iron housing . . . hardened, precision, double or triple reduction gear sets accurately provide required speed.

Space requirements and layout problems are minimized by locating input and output shafts in the same horizontal and vertical planes. Design of drive permits the addition of integral, positive-locking backstop at any time.

Get the full story on these advanced new drives, ratios 6.2:1 to 292:1, in 16-page Book 2651. It's available from your nearby Link-Belt office or authorized stock-carrying distributor.

LINK-BELT

ENCLOSED DRIVES

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13,201

Thermal Resistance...Chemical Resistance!

Now Available!

- **DACRON***
- **ORLON†**
- **NYLON**
- **ARNEL®**
- **ACRILAN****
- **DYNEL††**

Send today for fact sheets!

*DuPont trademark for its polyester fiber
†DuPont trademark for its acrylic fiber
**Acrylic fiber by Chemstrand
††Union Carbide's acrylic fiber

Now, American, through its technical research, has perfected the mechanical interlocking of the man-made fibers listed at the left, to produce three-dimensional felt structures.

These new Felts by American have exceptional *chemical resistance* with *thermal stability* to 300 F. They are non-hygroscopic, biologically stable and are available in a complete range of thicknesses. Precision engineering assures close density and thickness control.

The properties which characterize these new Felts are being utilized in filtration—laminated plastics as reinforcing material—high temperature bearing seals—gasketing. In fact, end uses are unlimited!

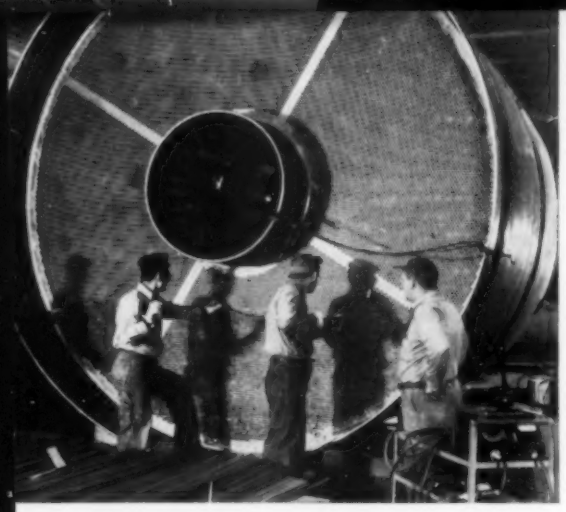
American's engineering and research staff is prepared to supply you with complete data and product recommendations. Write today!

American Felt Company

TRADE MARK ®

GENERAL OFFICES:
78 GLENVILLE ROAD GLENVILLE, CONN.

SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Greenville, S. C., Dallas, San Francisco, Los Angeles, Portland, San Diego, Seattle, Montreal.—PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I.—ENGINEERING AND RESEARCH LABORATORIES: Glenville, Conn.



FOR HIGH TEMPERATURE STRENGTH. This looks like a sieve, but actually it is a Stainless Steel plate punched with 25,400 holes, and it makes up the end plate of a chemical plant heat exchanger. After the tubes were inserted the exchanger was placed in high-temperature, intensely corrosive 24-hour service. It was made by the Nooter Corporation, St. Louis.

NOTHING *can equal* *Stainless Steel*

for its combination of desirable properties

No other design material can match Stainless Steel in its combination of desirable properties: corrosion resistance, strength and hardness, beauty, cleanability and easy fabrication. When seeking a source of supply, remember that United States Steel offers you the widest range of types, finishes and sizes.

FOR CORROSION RESISTANCE. Rare Earths, Inc., produces such valuables as cerium, lanthanum and praseodymium by means of an elaborate chemical separation process. In the filter press, corrosion destroyed carbon steel plate rods in six months. Stainless Steel rods were installed over six *years* ago, and are still in fine condition.

FOR TAKING A BEATING. These are 8th grade students from Dormont, Pa., public schools in a domestic science class. The sink tops were made by Pride Mfg. Co., Pittsburgh, from USS Stainless Steel. Says Pride, "These Stainless sink tops are ideal for school use. We've seen some 20-year-old sinks that still look as good as new."

UNITED STATES STEEL CORPORATION, PITTSBURGH · AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO · NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS STAINLESS STEEL

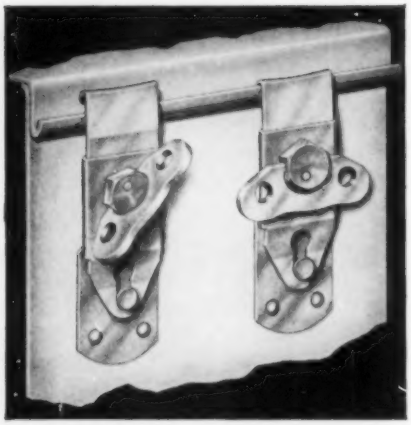
SHEETS · STRIP · PLATES · BARS · BILLETS
PIPE · TUBES · WIRE · SPECIAL SECTIONS

USS

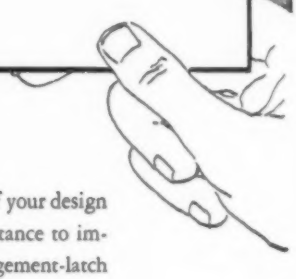
UNITED STATES STEEL

Have you a similar fastening problem?

File: Simmons LINK-LOCK



When the armed forces needed a positive, high-strength fastening device for instrument housings, transit cases, and storage boxes, Simmons developed LINK-LOCK. This *brand-new* device doesn't use springs, yet works with fingertip pressure through a unique mechanical arrangement: the vertical sliding latch is moved in and out of locking position by a disc rotated with a wing nut. The fastener is immune to low temperatures, is easy to operate even with arctic mittens, furnishes up to 450-lb. pull-down pressure. Open or closed, it lies flat against the side of the case it fastens.



LINK-LOCK may be the answer to your fastening problem. If your design involves heavy fastening pressures, watertight sealing, high strength, resistance to impact, ask about LINK-LOCK. Simmons can furnish it with special engagement-latch details, or for operation by bolt or screwhead instead of wing nut. Write for LINK-LOCK DATA SHEET today. It gives complete details and dimensions. A Simmons engineer will be glad to work with you on your fastening problems.

SIMMONS FASTENER CORPORATION, 1751 No. Broadway, Albany 1, New York

Simmons

QUICK-LOCK
SPRING-LOCK
ROTO-LOCK
LINK-LOCK
DUAL-LOCK

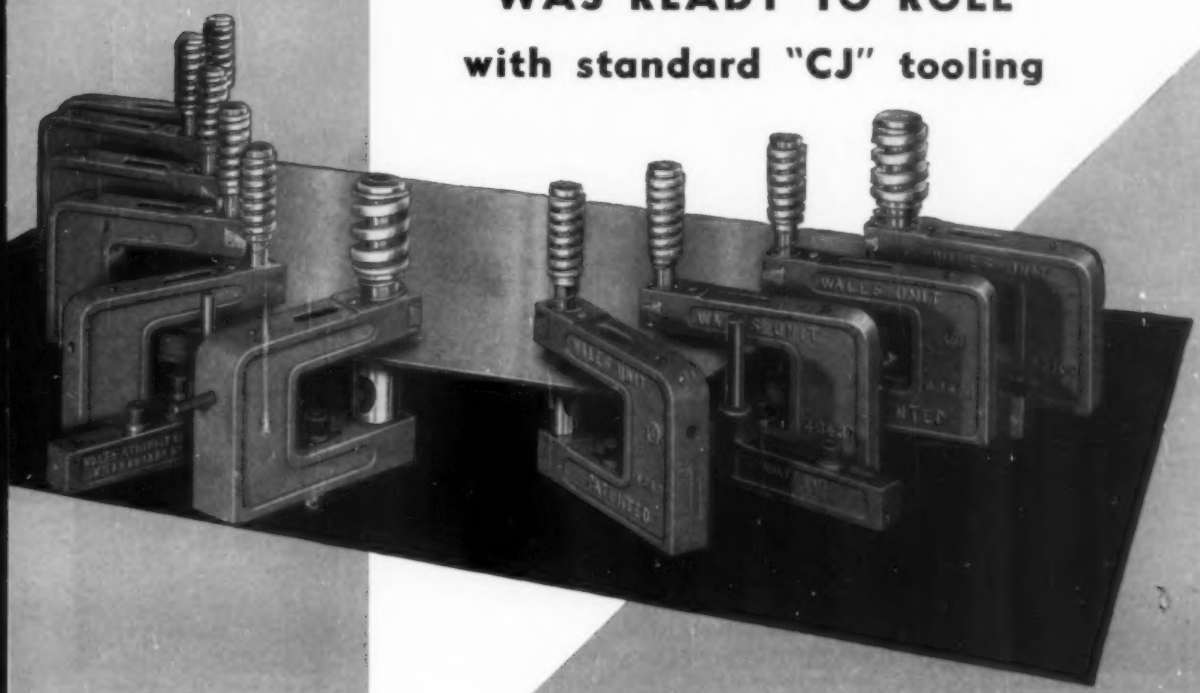
JUST OUT!
NEW 36-PAGE CATALOG WITH APPLICATIONS
SEND FOR IT!

FASTENERS WITH USES UNLIMITED

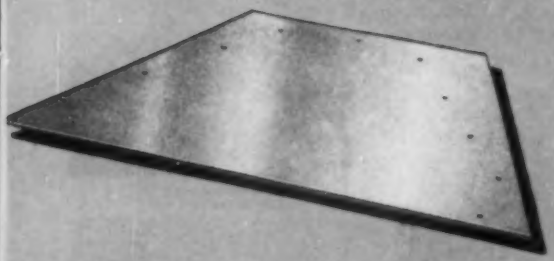
6 minutes . . . 45 seconds
and this ten hole

WALES PUNCH SET-UP

WAS READY TO ROLL
with standard "CJ" tooling



HERE'S THE RESULT EVERY 12 SECONDS



. . . and any good mechanic can make a similar set-up in a matter of minutes. WALES *standardized punching units* are completely self-contained . . . punches and dies are permanently aligned . . . nothing attached to press ram. They will always save hours . . . and often DAYS in set-up time.

Rugged type CJ units will punch holes up to 1¼" diameter in material up to ¼" thick . . . unlimited straight line, scattered and staggered, round or shaped hole punching patterns. Die retention design features rapid die change WITHOUT REMOVING DIE from set-up . . . provides controlled slug ejection.

No "dead storage" the WALES WAY! The same group of units can be used *over* and *over* again in other patterns.

Get this time-saving, money-saving story. Write for fully illustrated, fact filled catalog. NOW!

Send for BULLETIN NO. 14G
Illustrated with actual job work and full of interesting data and suggestions that you can adopt for your shop.

WALES Strippit CORPORATION
"...the Wales-Way is the PLUS-PROFIT way"
345 PAYNE AVE. — North Tonawanda, N.Y.
WALES-STRIPPIT OF CANADA LTD., HAMILTON, ONT.

"What genius invested our deposits in 6 tons of rust?"

Firestone EXON

The one expense the controller can't control is unchecked corrosion!

Firestone EXON

Corrosion's just a lot of rot to an aggravated stockholder!

Firestone EXON

Alerted by Firestone, management is joining your battle against corrosion

The menace of corrosion and its tragic waste have now been thrust into the consciousness of executives on every level of management.

The sound counselling, pressed upon management by technical men for years, has been featured in a challenging series of advertisements over the Firestone Exon signature. It has alerted top-management to the effect of corrosion on every job and function of industry.

This campaign has made the case and eased the way for technical men. Technologists who have long known the power of PVC to stop corrosion cold are now getting the green light.

It's entirely fitting that Firestone Exon resins should lead in publicizing the technologist's war on corrosion. Firestone Exon has been campaigning against corrosion for many years.

This expanding line has proved itself in such diverse applications as self-supporting structures, dip and spray coatings, tank liners, pipes and fittings, valves and paints.

Whatever corrosives you use, whatever equipment you must protect, drop a note to Firestone today.

Firestone

Who tripped up the Chairman of the Board with a corroded beam?

Firestone EXON

Who chained the Executive Vice President to his desk with a lot of corroded metal?

Firestone EXON

Who keeps boxing in the Traffic Manager with corroded grates?

Firestone EXON

What's that corroded flue doing in the Treasurer's office?

Firestone EXON

"That'll be $10 for the order and 25¢ for the corrosion!"

Firestone EXON

CHEMICAL SALES DIVISION • Firestone Plastics Co., Dept. 66K, Pottstown, Pa. • A Division of the Firestone Tire and Rubber Co.

Brush wire, crimped (as shown) or straight, now produced in multiple strand, and furnished in coils or straight banks depending on wire size.

How a **new idea in wire** *cleaned up a brush production problem*

● Maybe you can profit by the kind of interest and action applied to customers' problems by the Worcester Wire Works Division of National-Standard. Take wire brush manufacture for example . . .

Until recently, brush manufacturers had to cut through a coil of wire, then gather by hand and by guesswork the approximate number of wires for the type of brush in production. Naturally this involved a lot of cut-off waste, plus the wire lost through faulty guesswork.

Now, to overcome this waste, Worcester Wire Works has developed ways to produce and furnish wire in predetermined bunches (up to 400 wires per bunch) with *exactly* the right number of wires for a given brush. Much costly loss is eliminated, more brushes are produced per pound of wire, and production is speeded.

The point is, Worcester Wire Works people specialize in more than quality wire. They also specialize in the kind of service and exploration that time and again cuts costs for customers. Better check with them on your wire needs. You'll like the way they do business.

NATIONAL-STANDARD COMPANY • NILES, MICHIGAN
Tire Wire, Stainless, Fabricated Braids and Tape

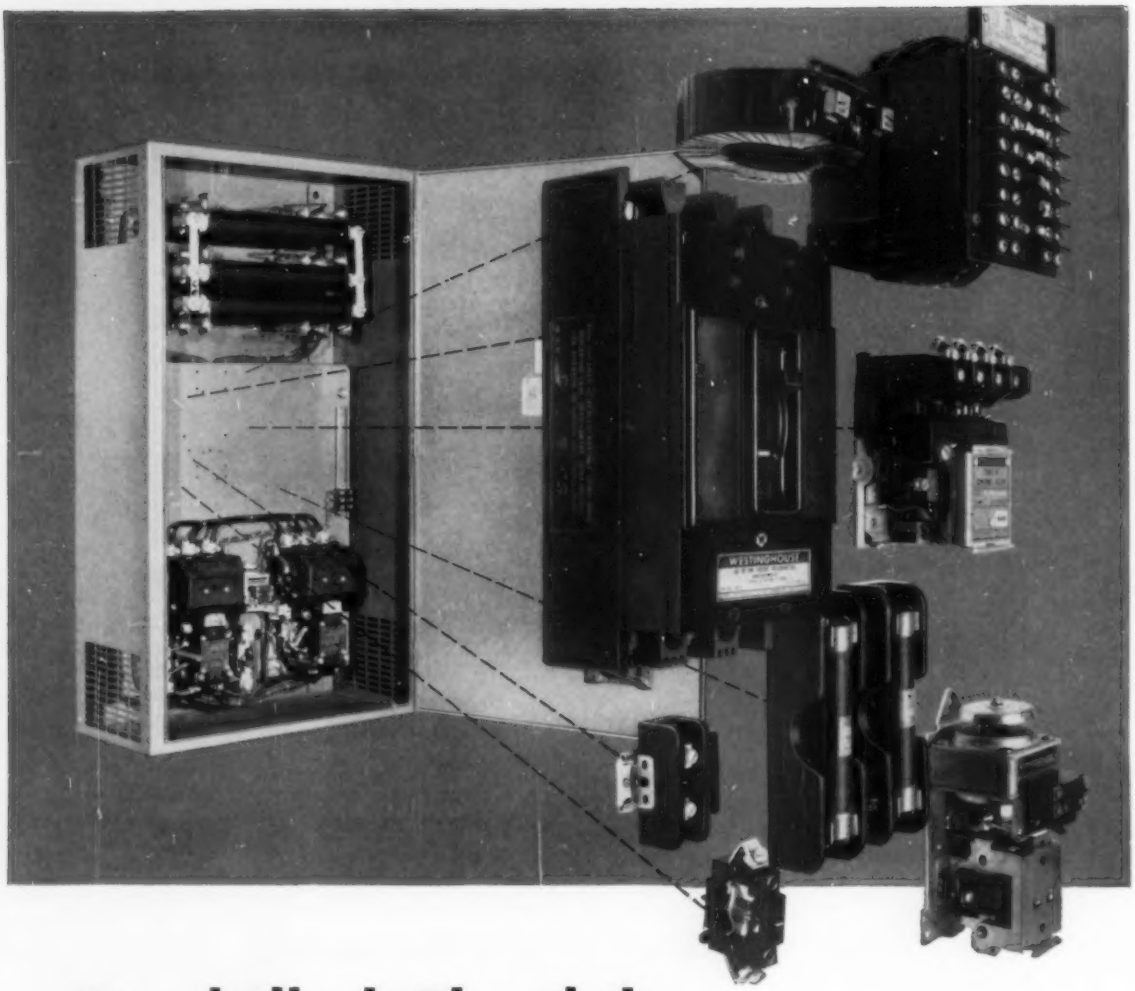
ATHENIA STEEL DIVISION • CLIFTON, N. J.
Flat, High Carbon, Cold Rolled Spring Steel

REYNOLDS WIRE DIVISION • DIXON, ILLINOIS
Industrial Wire Cloth

NS
NATIONAL-STANDARD
NILES, MICHIGAN

WAGNER LITHO MACHINERY • JERSEY CITY, N. J.
Special Machinery for Metal Decorating

WORCESTER WIRE WORKS DIVISION • WORCESTER, MASS.
Round and Shaped Steel Wire, Small Sizes



Predrilled Flexibility

The Westinghouse Reduced-Voltage Starter

Room to grow is built right in at the factory with the Westinghouse Add-A-Part panel. When additions to systems require such modifications as control circuit fuses, auxiliary relays, or current transformers, the space for them is there—engineered right into industry's most advanced reduced-voltage starter.

Other features that make this starter the most flexible, available today include pneumatic types AM and AMB relays for easy, stepless timing adjustment—adjustable resistor taps so you can adjust starting voltages to meet your requirements.

For all the facts, call your Westinghouse sales engineer. Ask for DB 11-500. You'll see one more reason why you can be sure . . . if it's Westinghouse. J-21930

WATCH WESTINGHOUSE!

WHERE BIG THINGS ARE HAPPENING TODAY!

Bundy teams up with customer in designing more efficient compressor discharge tube

Here's just a sample of the help Bundy engineers can give you with your design problems

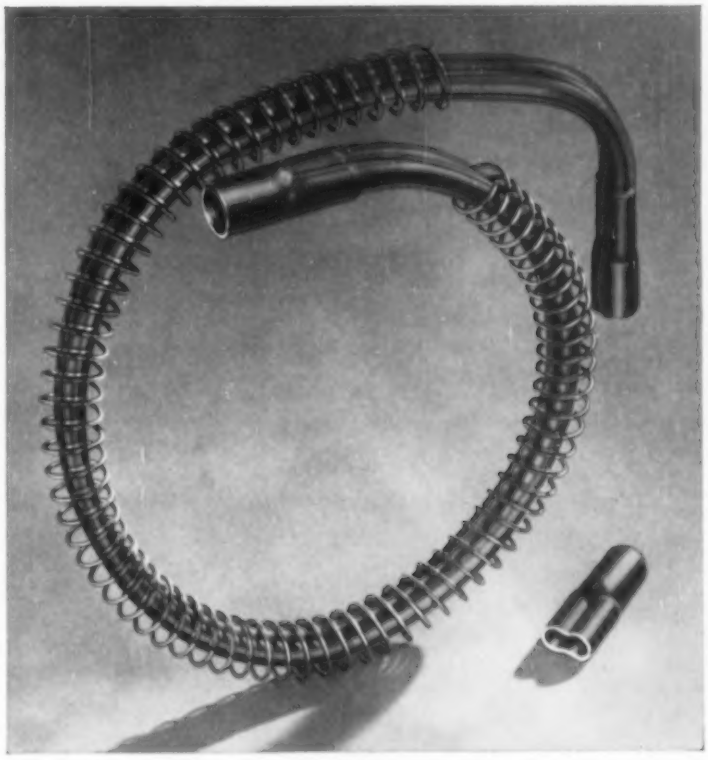
A leading manufacturer of refrigeration compressors—and a long-time Bundy customer—had this problem: an extra-sturdy compressor discharge tube was needed for use in its new, smaller, more efficient compressor. Together, Bundy® engineers and the manufacturer worked out the ingenious solution shown at right.

Bundy customers have come to expect this kind of teamwork when they deal with Bundy. Bundy engineers take pride in solving tricky tubing problems. They'll gladly work with you at the design stages of a new product; they'll also help you iron out kinks in your present tubing designs. Either way, you benefit from their years of problem-solving experience.

You benefit, too, from the inherent qualities that make Bundyweld Steel Tubing the world's finest small-diameter tubing. Bundyweld is the only tubing double-walled from a single metal strip, copper-bonded through 360° of double-walled contact. Bundyweld is leakproof; thinner walled, yet stronger; has high thermal conductivity; has high bursting strength. Bundyweld is not only the safety standard of the refrigeration industry; *it is used in 95% of today's cars, in an average of 20 applications each.*

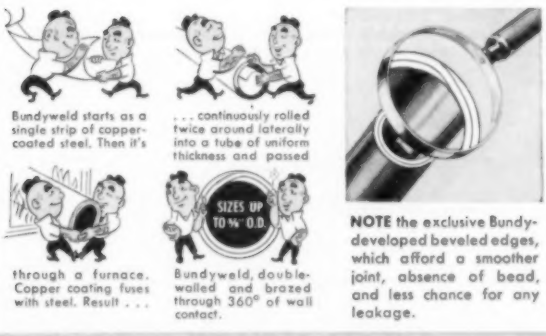
For help with your tubing design problem, call, write, or wire us today.

BUNDY TUBING COMPANY
DETROIT 14, MICHIGAN



Problem: Manufacturer needed extra-sturdy refrigeration-compressor discharge tube for new, smaller, more efficient compressor.

Solution: Discharge tube uses *double* tube for extra strength, superior resistance to vibration fatigue; the two separate tubes are brazed only at end fittings. Steel coil-spring sheathing muffles the noise that results from the vibration of this part. Discharge tube is designed so that O.D. of two tubes together is the same as O.D. of bifurcated Bundyweld end fittings, allowing spring to be slipped on after fittings have been brazed to double tube. Lower right: detail of formed Bundyweld end fitting.


Bundyweld starts as a single strip of copper-coated steel. Then it's
. . . continuously rolled twice around laterally into a tube of uniform thickness and passed
through a furnace. Copper coating fuses with steel. Result . . .
SIZES UP TO ⅝" O.D.
Bundyweld, double-walled and brazed through 360° of wall contact.

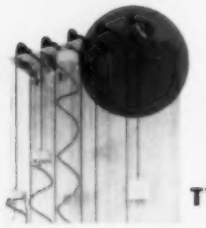
NOTE the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.

BUNDYWELD® TUBING

DOUBLE-WALLED FROM A SINGLE STRIP

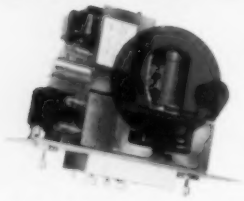
NEWLY DESIGNED

Howard Induction Motor Model 2900 Offers 18% Overall Improved Performance and Efficiency for Critical Applications



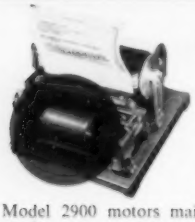
MERIAM MULTIPLE TUBE COMMON WELL TYPE MANOMETER

Model 2900 motors with gear units are used to motorize each well, quickly position the datum level required for the pressure range of the test involved.



MAGNECORD TAPE RECORDERS

Model 2900 is used in several MAGNECORD high fidelity professional units. Extremely quiet operation, minimum cogging, minimum mechanical vibration are major points in selection.



WESTERN UNION RECORDER #5616B

Mfd. by J. P. Seeburg Corp.

Model 2900 motors maintain an exactly constant speed, are extremely quiet and dependable. Selected by Western Union for their Recorder #5616B that transmits and receives messages from users office to Western Union office.

MODEL 2900—2 pole, 4 pole, 6 pole, 8 pole, 1, 2, or 3 phase and split phase applications. 1/100 to 1/15 h.p.

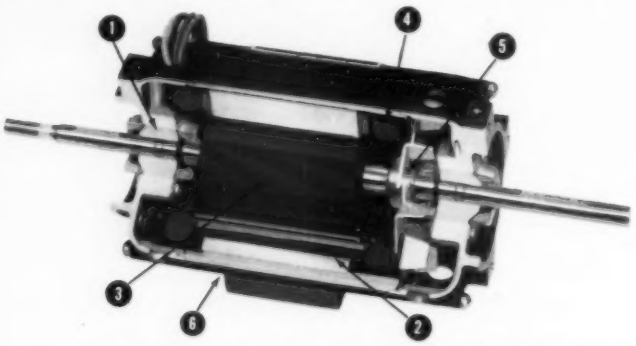
The applications shown above are just three of many applications now served by HOWARD MODEL 2900 motors.

The new HOWARD 2900 motor incorporates completely redesigned magnetic and electric circuits with increased stator and rotor slots, 24/20 slot lamination as against 16/14 slot lamination in the old 2900 design. The advantages are as follows:

- Six pole 2900 motors in Induction, Hysteresis and Torque types are now available. Of particular importance is the new six pole Torque motor which operates with extreme smoothness and practically no detectable variation of stalled torque throughout a rotor revolution. Almost perfect linearity in the speed-torque curve has been achieved at speeds varying from 0-1000 RPM.
- The new Reluctance Synchronous 2900 motor becomes suitable for many critical operations (in particular, tape recorders) where only expensive Hysteresis units were previously conceivable. Reduction of the external field permits the motor to be used without magnetic screening.
- The new 2900 design will permit operation of motor on 3 phase, 60, 180 and 400 cycle, 2/4/6 poles.
- The efficiency and power factor have been improved by an average of 20%. Heat rise is considerably lower which results in: a. Longer Motor Life b. Longer Bearing Life c. Minimum lubrication trouble d. Ability to operate in higher ambients
- There is substantially less mechanical vibration.
- There is less electrical and mechanical noise.

At request all 4 and 6 pole motors can be made reversible in motion.

Prices on the new Howard 2900 motor are moderate. Many gear ratios are available. Write today for complete information on MODEL 2900 and other Howard Induction motors, Series and D. C. motors and Shaded Pole motors. Howard's fractional h.p. motor selector chart is available on request.



1. "Selected" ball bearings permanently lubricated, sealed and shielded or sleeve bearings with large felt oil reservoirs with oil return system (shown). Sleeve bearing motors provided with ball thrust bearing for vertical operation.
2. 24 slot lamination design for quiet, cool operation. Stamped from high grade electrical steel.
3. Rotors dynamically balanced, skewed to give uniform torque characteristics with change of rotor angle.
4. Windings of heavy Formvar insulated wire, impregnated and baked with top grade electrical varnish.
5. Internal fan for cooling. 6. The case is a sturdy rigid casting.

Other Howard motors: UNIVERSAL & D.C. 1/200 to ½ h.p. • SHADED POLE 1/2000 to ⅓ h.p. • INDUCTION 1/1400 to ½ h.p. • SERVO MOTORS • GEAR MOTORS • BLOWERS

HOWARD

DEPT. PE-8 • HOWARD INDUSTRIES, INC. • RACINE, WIS.

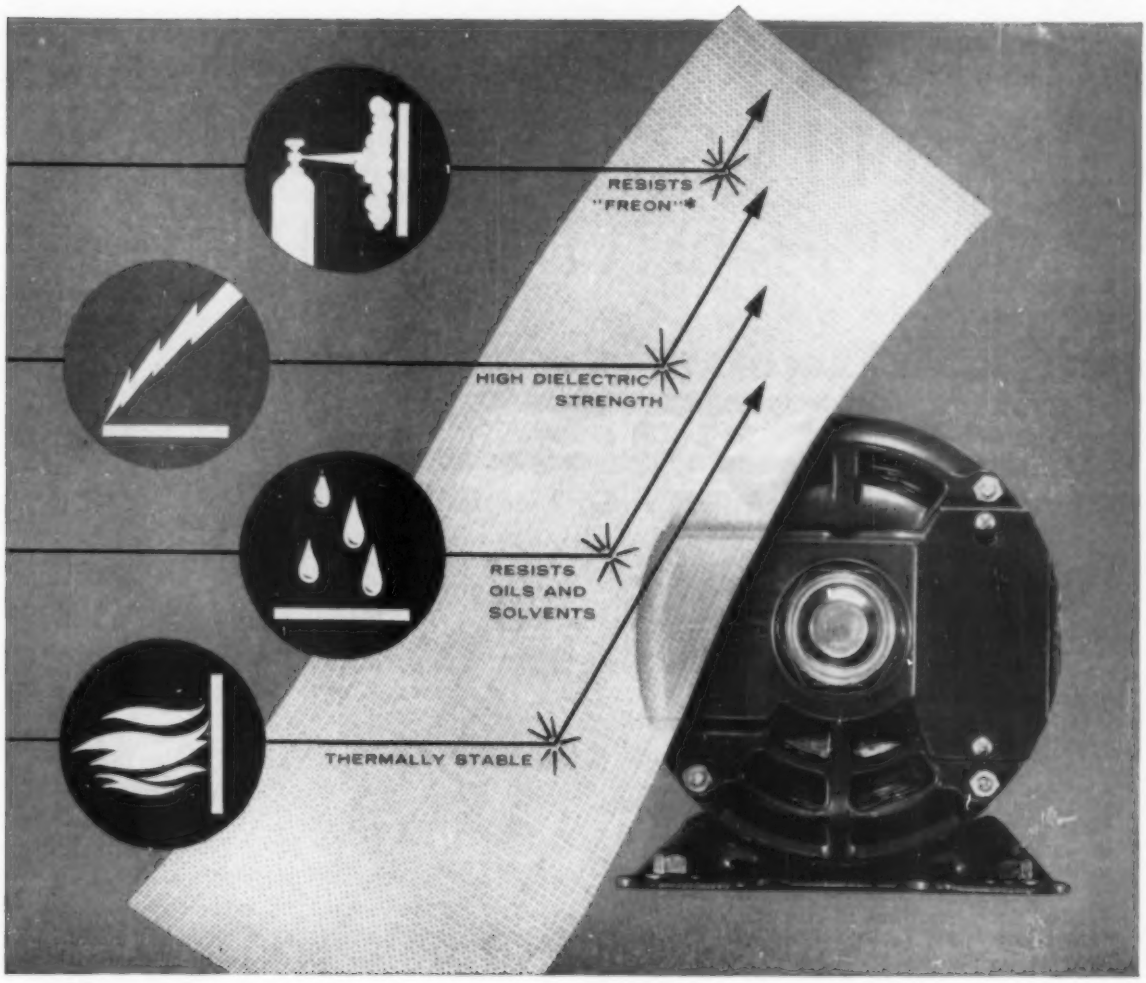
SALES OFFICES: 208 S. La Salle St., Chicago 4

942 S. La Brea Ave., Los Angeles 36 • Room 4822, Empire State Bldg., New York 1

Buy Defense Bonds

DIVISIONS: EMC ELECTRIC MOTOR CORPORATION CYCLOHM MOTOR CORPORATION RACINE ELECTRIC PRODUCTS

Du Pont offers new performance in a coated fabric



Superior electrical insulation at modest cost from "Lecton"** acrylic resin coated glass fabrics

Developed specifically for electrical insulation use, Du Pont "Lecton" acrylic resin coated glass fabrics offer superior performance at moderate cost. "Lecton" resists solvents, oils and "Freon" refrigerants—can be used for extended periods up to 300° F. High humidity does not affect the dielectric properties of this new Du Pont coated fabric.

So new it is still only in limited production, "Lecton" can be produced in single-ply materials, as tape or multiple-ply laminates in a wide range of thicknesses. In addition to glass-fabric construction, "Lecton" is made with various synthetic-fiber fabrics. If you need insulation for refrigeration applications or where high performance at modest cost is required, it may pay you to investigate the properties of "Lecton" acrylic resin coated fabrics.

Fill out and mail the coupon for complete data on this new coated fabric. If you're a manufacturer of electrical equipment, we'll send you samples of single-ply material for your evaluation. It's free—mail the coupon today.

*"Freon" is Du Pont's registered trademark for its fluorinated hydrocarbon refrigerants.
**"Lecton" is Du Pont's registered trademark for its acrylic resin coated glass fabrics.

DU PONT INDUSTRIAL COATED FABRICS

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

E. I. du Pont de Nemours & Co. (Inc.)
Fabrics Division, Dept. PE-68, Wilmington 98, Del.

☐ Please send me your bulletin on the properties of "Lecton" acrylic resin coated glass fabrics.

☐ Please send me a sample of "Lecton" for my evaluation.

*Name*_____ *Position*_____

*Firm*_____

*Address*_____

*City*_____ *State*_____

NOW...A GREAT, NEW ADVANCE IN MEASUREMENT AND CONTROL OF RELATIVE HUMIDITY

SIMPLE • FAST • ACCURATE • DEPENDABLE

EL-TRONICS

HUMIDITY SENSING ELEMENT

An entirely new principle . . . completely stable over long periods . . . mass produced at low cost.

Composed of a specially treated plastic material, the El-Tronics Humidity Sensing Element (patented) is only 5/8" wide, 1½" long, and 1/32" thick.

The resistance of the element varies as the logarithm of the relative humidity. The signal produced by the resistance change may be amplified and used to operate indicators, recorders, and controls.

RAPID RESPONSE

Reaction to humidity change is rapid, 67% of the change registers within 30 seconds on standard production elements. This reaction time can be reduced to 1 second for special applications.

ACCURATE OVER WIDE TEMPERATURE RANGE

For use over a wider range than heretofore possible, from -5° to 80° C (23° to 176° F), the standard element has a repeat accuracy within 3% R.H. Long-term stability and maintenance of calibration under adverse conditions are additional features of the El-Tronics Humidity Sensing Element.

MANY APPLICATIONS

The El-Tronics Humidity Sensing Element is applicable to the entire field where relative humidity is measured or controlled. This includes humidifiers, dehumidifiers, dehydrators, dryers, home and industrial air conditioning, packaging process control, industrial, educational, and government laboratories.

PROVED PERFORMANCE

The El-Tronics Humidity Sensing Element is the result of five years of research and intensive tests under a wide range of operating conditions.

SPECIFICATIONS

Standard Ranges, R.H.: 10-100%, 20-100%, 40-100% 10-50%, 20-50%, 10-25%
Ambient Temperature Range: +23° to 176° F
Repeat Accuracy: Within 3%
Reaction time, standard models: 67% of change registers within 30 seconds
special models: 67% of change registers within 1 second
Dimensions: 5/8" wide, 1½" long, 1/32" deep

FOR COMPLETE INFORMATION ON QUOTATIONS . . . PHONE . . . WIRE . . . OR WRITE:

EL-TRONICS INSTRUMENTS FOR THE MEASUREMENT AND CONTROL OF RELATIVE HUMIDITY

EL-TRONICS *Laboratory* HYGROMETER

Complete range of 10 to 100% R.H. Measures to 1% R.H.

MODEL 101

This is a precision 3-scale measuring instrument and can be used as a secondary standard. It is accurate within ±1% R.H. This hygrometer is plugged into a 110 volt a-c outlet to operate and is compensated for line voltage variations.

SPECIFICATIONS

Ranges: 40-100% (2% Graduations)
20-50% (1% Graduations)
10-25% (1% Graduations)
Calibration Accuracy: 1% R.H.
Power: 105-125 volts, 50-60 cycles
Size: 8" x 10½" x 10½"
Finish: Hammertone Gray

EL-TRONICS *Portable* HYGROMETER

Lightweight . . . Accurate . . . Battery Operated

Designed especially for humidity measurement work where a-c voltage may not be available. Under intermittent use, batteries are good for over 200 operating hours.

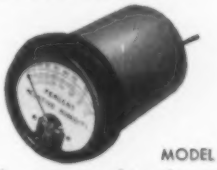
Range of 10-100% R.H. permits measurements of 10-50% R.H. in 1% graduations and of 20-100% in 2% graduations.

SPECIFICATIONS

Range: 10-100% R.H. (2 scales)
20-100% (2% Graduations)
10-50% (1% Graduations)
Calibration Accuracy: 2% R.H.
Power: Batteries
Battery Life: 200 hours (Intermittent)
Size: 5" x 6" x 7"
Weight: 6 pounds
Finish: Hammertone Gray

EL-TRONICS *Panel* HYGROMETER

Inexpensive . . . Versatile



MODEL 102

For panel mounting in industrial applications. Through external switches, any number of sensing elements, remotely located, may be connected to the meter singly.

SPECIFICATIONS

Range: 20-100% (2% Graduations)
10-50% (1% Graduations)
Calibration Accuracy: 4% R.H.
Power: 117 volts, 60 cycles
Size: 3½" x 3½" (Cylindrical)

EL-TRONICS *Industrial Humidity Control*

Manual or automatic . . . controls over full range 10-100% R.H.

MODEL 201 and MODEL 202

This is an electronic relay which is available in two types depending upon differential. Model 201 has a differential of ± 5% R.H. and Model 202 has a differential of ± 1% R.H. A standard thyratron tube "triggers" the relay. Contact rating is ample for electrical equipment rated up to ⅓ h.p.

SPECIFICATIONS

Range: 10-100% R.H.
Differential: Model 201—±5% R.H.
Model 202—±1% R.H.
Contacts: Double Pole, Double Throw
Current: 10 amperes
Power: 117 volts, 50-60 cycles
Size: 4" x 4" x 5½"
Finish: Hammertone Gray

EL-TRONICS, INC.
Plant: MAYFIELD, PA. JERMYN 1450
1420 Walnut St., Philadelphia 2, Pa.

EL-TRONICS, INC.
Mayfield, Pennsylvania

Please send me complete information on

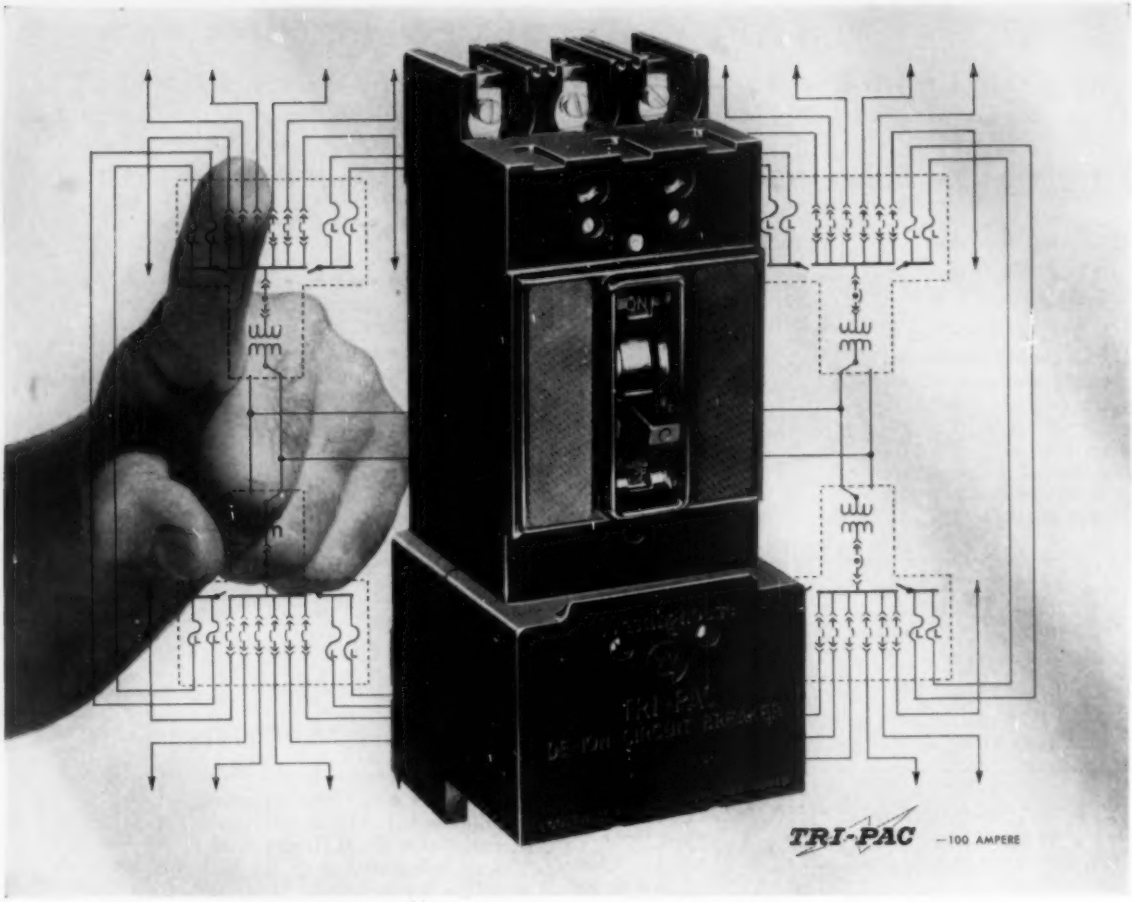
Laboratory Hygrometer . . . . . _____
Portable Hygrometer . . . . . _____
Panel Hygrometer . . . . . _____
Industrial Humidity Control . . . . . _____
Please have representative call . . . . . _____

NAME_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE____ STATE_____



100,000 amps gets a new boss— the Westinghouse Tri-Pac breaker

The new Westinghouse Tri-Pac breaker is the smallest protective device for electrical circuits where 100,000 amps can be poured into faults. It is the most practical and economical solution to the constantly increasing interrupting requirements of network systems and those fed by large transformers.

Co-ordinated triple circuit protection—thermal, magnetic, and current limiting—combines the inherent advantages of both the molded case breaker and fusible current limiters. The breaker trip portion of the Tri-Pac handles overloads and moderate faults, eliminating fuse replacement. On higher currents, the current limiters in Tri-Pac trip before the breaker portion, insuring the prompt protection required at high currents.

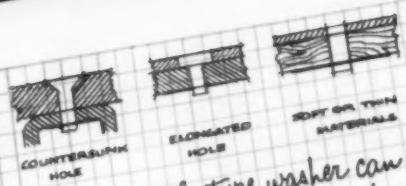
Tri-Pac costs much, much less than large air current breakers of equivalent rating and provides more safety and convenience than switches combined with fusible elements. New Tri-Pac breakers insure positive protection against all system current faults—large or small—at a new and greater economy.

A Westinghouse sales engineer can show you additional reasons why the new Tri-Pac breaker is your best buy for powerful circuit system protection. Call him, today. J-30216

WATCH WESTINGHOUSE!

COVER THE PRESIDENTIAL CAMPAIGN ON CBS TV AND RADIO!

HOW A YOUNG DESIGN ENGINEER PUT BETTER QUALITY INTO HIS PRODUCT



No single type washer can do the right locking job on all applications!

We need the right washer for every job... LOCK washers that really LOCK... such as SHAKEPROOF'S job-tailored line

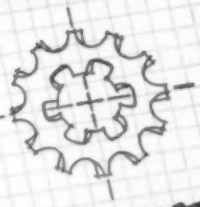
for example, among SHAKEPROOF'S nine standards, the countersunk lock washer keeps countersunk screws locked tight!... Or, use the dome type for soft or thin materials and oversize or elongated holes.

for special problems and special savings... SHAKEPROOF "Specials" have practically no limit in design or application!

All SHAKEPROOF® Lock Washers have tapered-twisted teeth that bite deep, set up strut and spring action to resist backward rotation, A PERFECT LOCK EVERY TIME!

So next time use SHAKEPROOF LOCK WASHERS

The "job-right" lock washer locks tight every time



Improve quality... CUT COSTS!

SEND FOR "SHAKEPROOF SAMPLER"

Write today for SHAKEPROOF LOCK WASHER samples and useful "How to Choose" booklet!

SHAKEPROOF

"Fastening Headquarters" ®

St. Charles Road, Elgin, Illinois • Offices in Principal Cities
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SHAKEPROOF
FASTEX

DIVISIONS OF ILLINOIS TOOL WORKS
World's Broadest Line of Mass-Assembly Fastenings

Crankshaft Machine Company uses La Salle's

NEW fatigue-proof STEEL BARS

to replace heat-treated alloy

- **140-150,000 PSI TENSILE**
- **MACHINES 50-100% FASTER**

FATIGUE-PROOF is specified in this automated turning machine manufactured by Crankshaft Machine Company, Jackson, Michigan.

This $60,000 machine uses FATIGUE-PROOF for a vital part. The rack that actuates the loading mechanism formerly was heat-treated alloy and is now FATIGUE-PROOF.

This is an automatic crankshaft turning machine that operates in automotive production lines. It must run dependably. The engine line can't wait for machine repairs.

The rack itself is intricate and machining it was a problem. FATIGUE-PROOF solved that, and it did so at no risk to the machine!

If you are producing parts requiring tensile strengths in the 140,000 to 150,000 p.s.i. range . . if you are interested in a steel bar that has this strength without heat treating . . if you want to trim production costs with a bar that machines faster (25% faster than annealed alloys, 50% to 100% faster than heat-treated alloys) . . if you want to eliminate the cost and inconvenience of heat treating, we invite you to send us a blueprint or detailed description of your application or, better yet, pick up your telephone and call your nearest La Salle Sales Engineer.

TEST FATIGUE-PROOF! If it appears that FATIGUE-PROOF can help improve the quality of your product or cut your production costs, your La Salle Sales Engineer will be glad to furnish you with a sample bar for testing in your own plant.

NEWLY PUBLISHED!
Ask for your copy of this 20-page booklet which gives detailed information on the remarkable new FATIGUE-PROOF . . 29 pictures, tables, charts.

La Salle STEEL CO.
1416 150TH STREET, HAMMOND, INDIANA
Manufacturers of America's Most Complete Line of Quality Cold-Finished Steel Bars

LA SALLE STEEL CO.
1430 150th Street
Hammond, Indiana

Please send me your "FATIGUE-PROOF" Bulletin.

Name_____

Title_____

Company_____

Address_____

City_____ Zone____ State_____

Perspectives

IN DESIGN AND DEVELOPMENT

USER TESTIMONY OVER SCIENCE

In passing on the truth or lack of same of advertising claims made for commercial products, the government is adopting a policy of accepting the testimony of the users of a product in preference to that of trained scientists who test it in a laboratory. Two court tests prove this point. One case was finally settled last November in favor of the manufacturer, after a three-year battle with the Federal Trade Commission and the Post Office Department. The second case is just starting its sojourn through the courts, but the first decision in its favor indicates that it will run the same course.

THE AD-X2 CASE

The most publicized of the two cases concerns the battery additive AD-X2. The case actually dates back to 1949 when the maker of the additive, Jesse Ritchie, president of Pioneers, Inc., objected to one of the circulars periodically published by NBS stating that no additive known to Bureau materially improved battery performance or life. This included AD-X2, although brand names are not mentioned in such circulars. These circulars are issued to give general information to be used as a standard for government purchasing. Some private buyers get these circulars for their personal use when making purchases.

Ritchie demanded that his product specifically be exempted from this circular, but NBS refused. The National Better Business Bureau went along with NBS in stating that all battery additives were useless. About this time, 1950-1951, the FTC and the Post Office Dept. were set to bring fraud charges against Ritchie, and asked for further tests on AD-X2. Then the pressure began.

NBS ACCUSED OF SHOWING FAVORITISM

Ritchie claimed he was being unfairly treated because he was just a small businessman, and that users would testify as to the merits of the additive. A Senate Small Business Committee took Ritchie's side in 1952, and had a favorable research report prepared by group at the Massachusetts Institute of Technology. In 1953 the Post Office issued a fraud order, and one week later Secretary of Commerce Sinclair Weeks, and Senator Thye of the Small Business Committee had the order suspended. Weeks accused the Bureau of refusing to run tests that would show that Ritchie's additive had merit, and furthermore accused Bureau scientists of being in league with groups opposed to Ritchie's additive. The resignation of Allen Astin, director of NBS, followed.

In the formal hearings that got under way in June 1953, Ritchie offered as his defense his own version of the popular advertising jingle, "ask the man who owns one." Senator Thye chose to look at the hundreds of testimonials of satisfied users because he knew nothing of the technicalities of a laboratory test. He said to Astin, "that is where you always get us, because as a scientist you can get into that technical field, and we

(continued on page 131)

custom-molded by Chicago Molded Products

polystyrene bandsaw cover made lighter, stronger, at lower cost...

An important feature of this new Magna 11" Bandsaw is its injection-molded styrene cover. It's lightweight – important to the operator who must remove the cover to change blades . . . it's strong and sturdy. Here's product enhancement . . . at a saving; for it costs less than a die cast part.

What's more, it eliminates painting during manufacture. For the attractive turquoise blue Magnaline color is in the plastic – it can't chip, peel, or fade – ever.

Let Chicago Molded's service engineers help re-examine your products. They may be able, just as they did for Magna, to suggest ways to make them better, and lower cost through the use of molded plastic parts. And our unbeatable facilities mean prompt, economical delivery of *any* size part you need . . . in *any* quantity. *That's why 60% of our business comes from firms we've served for 15 years or more.*

If you'd like to receive news of new plastic applications and developments, send us your name and address. We will be glad to send you periodic copies of the magazine *Plastics Progress*.

CHICAGO MOLDED PRODUCTS CORP.

1032 N. Kolmar Ave., Chicago 51, Illinois

are left in a daze. We are not sure whether we dare challenge you or not."

Democrats accused Weeks of using the AD-X2 incident to make their own political appointments in NBS, a government agency usually regarded as outside the realm of politics and patronage. The result was that Astin was reinstated, and a special 11-man committee of the National Academy of Sciences studied NBS and its testing methods and gave it a clean bill of health. It also agreed with NBS that AD-X2 was without merit. Again the FTC, which had suspended its investigation, stepped in and formally accused the makers of AD-X2 with false and misleading advertising. Extensive hearings through 1954 and 1955 ended with Ritchie being exonerated.

FTC Hearing Examiner William Pack said that, "While the greater weight of scientific testimony is that AD-X2 is worthless, the overwhelming weight of user testimony is that AD-X2 is useful and beneficial. And, that the users testifying on behalf of the additive were, after all, experts in their own right on lead-acid batteries."

FTC REVERSES

Now, the FTC, formerly out to get Ritchie, has upheld the Hearing Examiners decision. Also, it rejected as unfounded the charges that NBS tests of AD-X2 were unfair and prejudiced. FTC also implied that the MIT tests in favor of AD-X2 were "insufficient for conclusions as to commercial utility" of the product. With the NBS testimony cancelling out that of MIT, the user testimony was all the more important.

HOW DOES THE WATER CONDITIONER WORK?

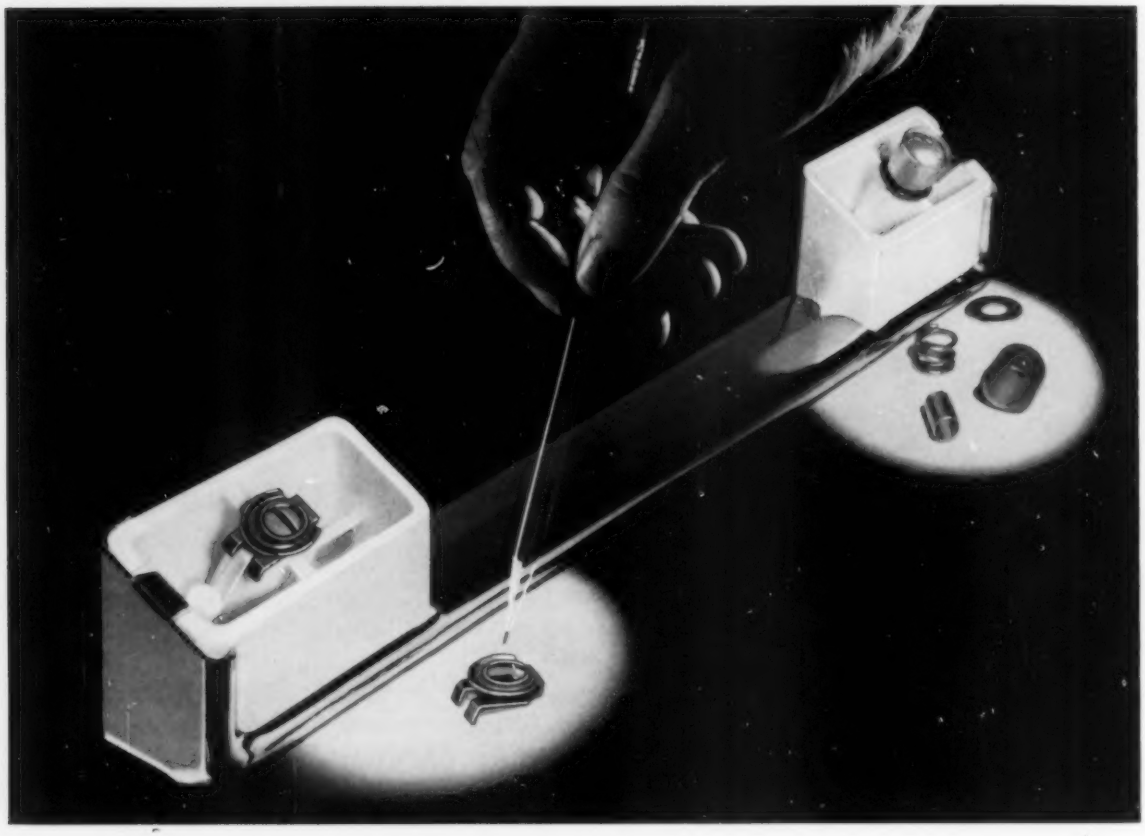
In the second case, that of the Evis Mfg. Co., manufacturers of a water conditioner, the FTC charged that the company misrepresented the operation and advantages of the conditioner. But the Hearing Examiner has recommended dismissal of the case because he claims that the FTC lawyers have not proved the charges. The original charges date back to 1954.

The water conditioner, which has been described as an oversize pipe coupling with an interior post integrally cast in place, is advertised as being made of a "specially processed metal capable of producing a catalytic effect on the water passing through it." Evis claims that it will solve hard water problems, yet he says that the device: is not a water softener; prevents and removes scale from boilers; reduces the cost of heating water; eliminates harshness of water to the hands; will not require as much soap; and is beneficial in agricultural irrigation.

A total of 122 witnesses testified during the hearing, 92 of whom were satisfied users of the product in industrial plants, lumber mills, hospitals, and other public buildings. Twenty-two of the witnesses were scientists who said that it failed to come up to the performance claimed for it.

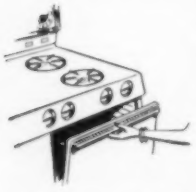
SCIENTISTS DO NOT KNOW

In summing up, the Examiner said that the device "appears to operate on a principal unknown to, or recognized by, present-day science, and that the scientists will not deny that the conditioner may operate as it is represented. Furthermore, we must not take the risk of interfering with the development of a device which may prove to be the first practical application of a scientific principal heretofore undiscovered."



Engineered by Tinnerman...

One-Piece SPEED CLIP® replaces 4-part fastener, helps assembly and shipping ... and saves money!



Four separate parts plus screw were required to fasten each end of the removable door handles on kitchen ranges manufactured by the Caloric Appliance Corporation, Topton, Pennsylvania.

Tinnerman fastening specialists teamed up with Caloric designers to eliminate 3 of the parts!

Now . . . a special one-piece, multi-purpose SPEED CLIP plus screw do the same job more efficiently and at lower cost, and reduce small parts handling. Faster, easier assembly . . . fewer parts to buy, inventory and handle. Packed inside the oven for safe shipment with SPEED CLIPS in place, the door handles are dealer-applied in far less time, can be easily removed by the housewife for cleaning.

The resiliency of the spring steel SPEED CLIP prevents crazing or chipping, enables it to absorb varying panel thicknesses and porcelain enamel build-up. Changeover was made without retooling or redesigning door handle or keyhole-shape mounting holes.

Find out now where SPEED NUT brand fasteners belong on your assembly line. There are more than 8000 variations to choose from. Call your Tinnerman representative for complete details and write for our Fastening Analysis Bulletin No. 336.

TINNERMAN PRODUCTS, INC. • Box 6688, Dept. 12, Cleveland 1, Ohio

Canada: Dominion Fasteners, Limited, Hamilton, Ontario. *Great Britain:* Simmonds Aerocessories, Limited, Treforest, Wales. *France:* Simmonds, S. A., 3 rue Salomon de Rothschild, Suresnes (Seine). *Germany:* Hans Sickinger GmbH "MECANO", Lemgo-i-Lippe.

TINNERMAN

Speed Nuts

FASTEST THING IN FASTENINGS®

Not Mañana But NOW

IN PRACTICALLY ALL HUMAN ACTIVITIES, speed is on the increase. Transportation, communication, manufacturing operations and even the speed of computing are many times greater today than only a few decades ago. And with increasing speeds have come greater problems in speed control.

Naturally, speed in the conduct of business must keep up with the faster tempo. Making decisions, which is the control factor in the operation of a business, has had to be speeded to keep in step with the faster transportation and production. Today, managerial decisions must be made more promptly and more definitely.

Unfortunately, there is the all too common temptation to postpone decisions, especially those that are of an irrevocable character. But nothing can be more irrevocable than postponement. Especially in those fields of business where the race is won by him who gets there first, even a short delay might be extremely costly.

Hesitancy, delay and postponement are usually impelled by fear born of ignorance. "I had better wait until I find out more about this!. . . .I wonder what the competitor is going to do!. . . .Let's first find out how the new competitor's model makes out!. . . .Let the other fellow pay the cost of all the research and then we can follow along!. . . . Maybe the market will drop and then we won't want to go ahead with our expansion plans!. . . ." These and dozens of other similar expressions have been used as the crutches for many a limping manager. The management that acquiesces to such an attitude is responsible for it.

The executives who do not bother to keep themselves informed until they face a problem that requires the information, can hardly be classed as progressive business men. The company that waits upon its competitor to take the step first is certainly not the leader in its field. The management that idly sits by waiting to find out whether the competitor is going to make a profit on the proposed venture can not be termed courageous. When a business resorts to copying the new products of its competitors it can never hope to be more than a poor second rater. And the company that waits to "follow the market" is certainly not a "blue chip." The company that is genuinely progressive makes the market—it does not follow the market.

There is a Spanish word mañana. It means tomorrow and it is pronounced mon-yanna. When it is said of a person or operation, "mañana mañana" it means that there is procrastination going on. In this day of speed procrastination may be fatal. The directives and decisions must be positive and prompt. There is no time for mañana in modern business management. 'Tis sometimes far better to make a wrong decision promptly than to make no decision at all.

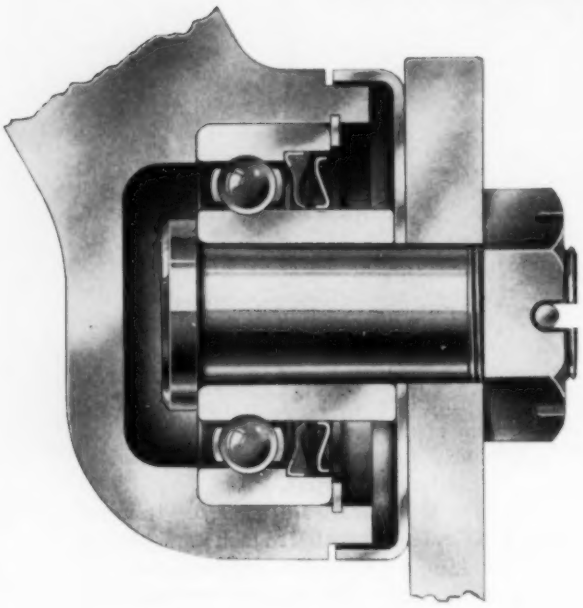
Nothing is more frustrating and stultifying to the engineers of a design department than to be forced to stagnate their product development programs because "somebody cannot make up his mind." Without decisions there can be no progress.

In the work of the engineering department "Mañana" must be "today—now."

George F. Bodenschatz

FACTS

about **NEW DEPARTURE**
BALL BEARINGS



Bearings are fully protected by flexible seal and metal slingers. Ample grease supply, kept free of contaminants, eliminates all need for relubricating. This means maintenance is zero.

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These NEW Departures in hay rake tine bar bearings have been developed to give both implement manufacturer and user bearings that are easily applied. Once installed, they can be entirely neglected—they are "built to be forgotten"!

New Departure hay rake bearings are designed to mount on standard machine bolts . . . or on flat-head, slotted studs like those shown in the sectional view. These special studs are available from New Departure.

When you specify New Departure ball bearings for farm implements, you are assured of bearings of proved capacity and performance. Complete details sent upon request.

Bearing bores are accurately sized to fit correctly on either standard machine bolts or on special studs shown. Bearings retained in tine bar end by simple snap ring. No drilling, tapping or threading required.

BALL BEARINGS MAKE GOOD MACHINES BETTER

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONN.

HYDRAULICALLY FED POWER SPINNING MACHINES, resembling heavy duty lathes, plastically deform metal disks over a spinning mandrel to obtain conical and cylindrical shapes. This 40-hp "Hydrospin" machine, made by the Cincinnati Milling Machine Co., has tracer-controlled rollers that can reduce a ¾ in. thick flat blank to a ¼ in thick cone.

Power Spinning

Advantages and limitations over other metal working processes; applications; effect on strength, hardness and fatigue of metals; tolerances, finishes and tool costs.

Conical and Tubular Parts

RECENT TREND in production of conical and cylindrical hollow shapes is the use of high pressure to plastically deform a metal blank over a spinning mandrel. The shape of the mandrel is identical to the desired contour of the part and the blank is cold formed by one or two rollers while spinning on a machine similar to a lathe. The process, therefore, superficially resembles spinning—but with several important differences. In spinning, the blank diameter is considerably larger than the diameter of the finished product. Simple hand tools are manipulated manually to fold the metal blank over a mandrel. Pressures are moderate and thickness of the blank is reduced only slightly; reduction in thickness is actually a by-product of the process and cannot be predetermined. Tolerances, therefore, are not sufficiently

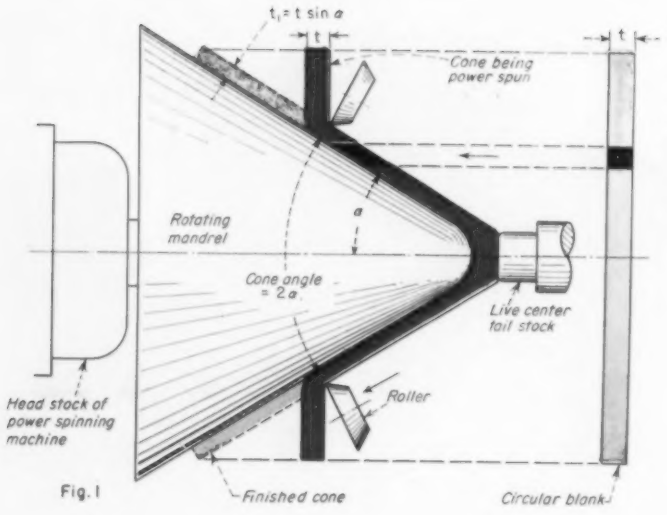


Fig. 1

Fig. 1—Circular blank of metal is plastically deformed in a horizontal direction by rollers moving parallel to mandrel and exerting pressures up to 400,000 psi. Relationship of blank thickness t to finished cone thickness t_1 is given by the equation $t_1 = t \sin \alpha$. Maximum diameter of cone will be equal to diameter of blank.

Fig. 2—Cones of varying wall thickness require use of pre-formed blanks. Details *A* and *B* show computations for obtaining thickness of cone wall at various sections.

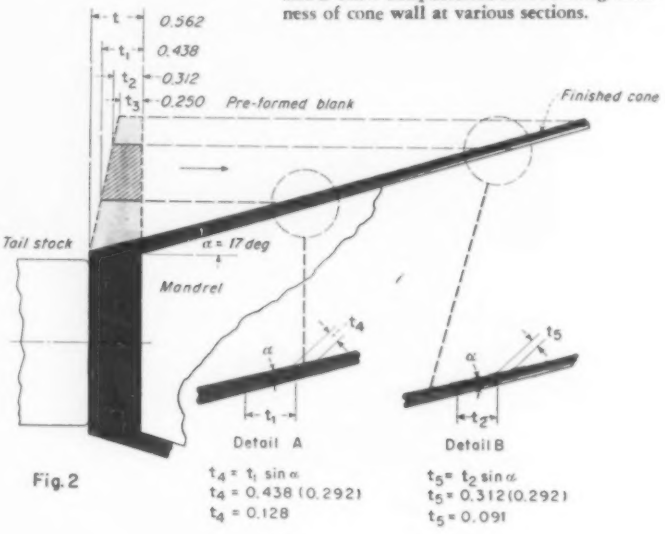


Fig. 2

close for most applications (±0.015 in. is usually the best that can be held.)

In the power spinning process (known by various trade names: *Hydrospin*—The Cincinnati Milling Machine Co.; *Floturn*—The Lodge & Shipley Company; *Power Rolling*—The DeLaval Separator Company) diameter of the finished product is exactly the same as the diameter of the original blank. The metal is squeezed ahead of hardened rollers which apply pressures up to 400,000 psi; sections are thinned by plastic deformation as illustrated in Fig. 1. Change in thickness is a function of the sine of the cone angle, the material being displaced in a horizontal direction only.

This comparatively simple process, which may be thought of as a combination of spinning and cold rolling, has some pronounced advantages over other metal working processes:

1. **Strength and hardness** of finished product greatly increased over original blank—up to 100 per cent.

2. **Fatigue resistance** increased—especially in notch sensitive materials.

3. **Close tolerances**, comparable to the machining processes, are possible (up to ±0.002 on thickness and inside diameters).

4. **Surface finish** is of high quality and comparable to finishes obtainable from surface grinding operations (6 to 8 micro-in.). Metal is burnished rather than cut; parts seldom require additional finishing operations.

5. **Scrap loss** almost completely eliminated. No material waste is involved except when blanks are stamped or machined.

6. **Small number of parts** usually can be produced more economically than by deep drawing, forging or machining because of low cost tooling.

7. **Large number of parts** produced more economically than by deep drawing if product involves complex contours.

8. **Flaws in material** show up during power spinning; process acts as its own inspector.

9. **Welded joints** are improved by plastic deformation during spinning; joints are less noticeable.

10. **High-alloy metals** difficult to machine offer no problem in power spinning. On the contrary, there are indications that high-alloy metals are easier to power spin because of fine grain structure.

Main limitations of the power spinning process are:

1. **Shapes are confined to cones or hollow cylinders.** However, even within this limitation, parts can have considerable complexity, such as reentrant contours, venturi forms and walls with varying thickness.

2. **Reduction in ductility** or elongation of the metal after power spinning. This is to be expected because of increase in hardness but is not a serious limitation for

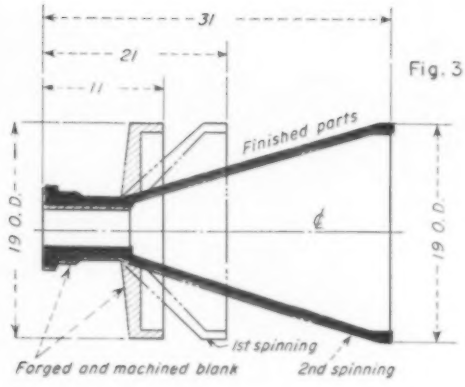


Fig. 3

Fig. 3—Turbine shaft originally forged and then machined to 19 x 31 in. dimensions. Machining of thin tapered walls was difficult and resulted in much material waste. Forging and machining now reduced to 19 x 11 in. dimensions and power spun in two passes to final dimensions using two mandrels. No heat treating necessary between passes; strength of forging and quality of surface finish increased by spinning.

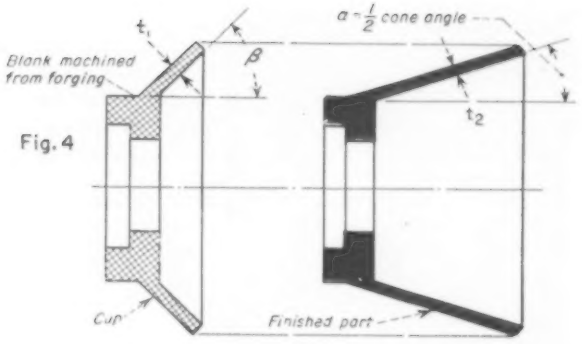


Fig. 4

Fig. 4—Machined blank made from shorter forging to reduce scrap loss. Blank is then power spun to desired thickness and cone angle. Cup-shaped blank must be used for cone angles less than 30 deg to avoid exceeding a 75 per cent reduction in thickness.

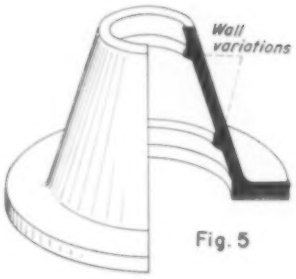


Fig. 5

Fig. 5—Cut-away of cone with annular wall variations to allow more material for threading of fasteners. Variations are obtained by controlling path of rollers with tracer attachment.

most applications. For critical uses the parts can be heat treated after spinning to increase ductility.

3. **Not competitive with deep drawing for long production runs** except where contours are complex. Tooling costs for power spinning are less than for drawing, but advantage is lost in long runs because of longer operation time per piece.

APPLICATIONS

Shapes successfully power spun are of four general categories: Straight wall cones, curvilinear wall shapes, hemispheric or elliptical shapes, and straight wall tubes.

Straight wall cones can be spun from flat blanks with maximum thickness dependent upon power of the machine and material being used. Stainless steel blanks up to $\frac{5}{8}$ in. thick, and aluminum and brass alloys up to $1\frac{1}{2}$ in. thick, have been shaped with no difficulty.

Smallest included angle considered practical in cone spinning is 30 deg. This results in approximately 75 per cent reduction in thickness of the blank according to the "sine law" illustrated in Fig. 1. Cones of varying wall thickness and cones with less than 30 deg apex angle require use of preformed blanks, Fig. 2. These blanks may be formed by casting, forging, machining, drawing, or power spinning on another mandrel. Forged blanks are useful in obtaining a thick ring at the hub of the finished part, such as the turbine shaft in Fig. 3; the machined blank in Fig. 4 is made from a forging reduced in length because of subsequent spinning.

For cone angles less than 30 deg, a cup-shaped blank may be required to avoid reducing the cone thickness more than 75 per cent. An equation to determine the cup angle β of the blank can be derived as follows:

From examination of Fig. 4:

$$\frac{\sin \beta}{\sin \alpha} = \frac{t_1}{t_2}$$

or

$$\sin \beta = \frac{t_1}{t_2} \sin \alpha \qquad (1)$$

If R is designated as the per cent reduction in thickness, then

$$R = \frac{t_1 - t_2}{t_1} \times 100$$

Rearranging terms gives:

$$t_2 = t_1 - t_1 \frac{R}{100}$$

or

$$\frac{t_2}{t_1} = 1 - \frac{R}{100} \qquad (2)$$

Substituting Eq (2) into Eq (1) yields

$$\sin \beta = \sin \alpha / (1 - R/100) \qquad (3)$$

As an example, to not exceed a 70 per cent reduction in thickness in obtaining a cone angle α of 10 deg, the cup angle β must be equal to or less than:

$$\sin \beta = \frac{0.174}{1 - .70} = 0.58$$

$$\beta = 35.5 \text{ deg}$$

By controlling the path of the rollers, usually with tracer control, variations in wall thickness can be achieved. Fig. 5 illustrates the use of wall variations to allow material for threading of fasteners.

Power spun cones can be welded to machined hubs to avoid complicated configurations in the blank piece. Fig.

6 shows the bottom of a stainless steel centrifuge bowl, drilled and welded to a tubular shaft after spinning.

Curvilinear shapes such as the housing cover in Fig. 7(A) can be power spun with either a gradual thinning wall, as computed in (B), or with a constant wall thickness, by using tapered blanks. In both cases, tracer control governed by templates is needed to synchronize the vertical and horizontal roller feeds.

Necked or venturi-shaped parts can be produced by using split mandrels connected together at the smallest neck diameter. The mandrels are separated after power spinning to permit removal of the part. The nozzle in Fig. 8 mounted on a split mandrel, required five passes before reduction to final dimensions.

Hemispheric or elliptical shapes of constant thickness can be power spun by using preformed blanks, as shown in Fig. 7 so that the "sine law" applies. Another method, making use of ordinary flat blanks, is still in the development stage. Wall thickness is reduced over 50 per cent in this new method so as to exceed the elastic limit of the material and cause it to hold to the mandrel diameter without springback. The mandrel and tracer template are made to the same shape and adjusted to the required wall thickness. Rollers are fed in the opposite direction, toward the tail stock, and the sine law does not apply. Maximum reduction in wall thickness is 90 per cent.

Some applications of hemispheric or elliptical shapes are: harrow disks and truck wheels (because of increased strength), hydraulic accumulators and washing machines.

Tube spinning offers advantages in obtaining both a high burnished finish and close tolerances on wall thickness and inside diameter. Typical close tolerance is ±0.003 in. on a 13 in. inside diameter; typical finish on inside diameter is 6 to 8 micro-in. This makes tube spinning ideal for producing hydraulic cylinders.

Tubes are power spun to length from inexpensive rolled and welded rings as shown in Fig. 9. For some materials seamless tubing is used in place of welded rings. Two methods are used: *forward tube spinning*—in which the tube is squeezed ahead of the rolls or *reverse tube spinning* in which the tube is extruded under the rolls in opposite direction from which the rolls are advancing.

In the more ductile steels, wall thickness of tubes have been reduced up to 90 per cent by using two or more passes of the rolls. Variations in wall thickness are possible by using tracer control or by resetting the rolls for different clearances from the mandrel. In addition, tubes with slight tapers can be rolled by setting the roller slide at an angle with the mandrel.

Increase in Strength and Hardness

Effect of power spinning on physical properties of metals is similar to changes resulting from cold rolling. A microstructure of a power spun metal, will show grains elongated in the direction of spinning. Theoretically, power spinning can be carried almost to the point of complete crystal deformation where the metal becomes fully hard. Reductions in thickness up to 95 per cent are within the realm of possibility but a limit of 75 per cent has been established by the industry for most power spinning applications.

Variations in tensile strength, yield strength, hardness and ductility (elongation) can be plotted against reduc-

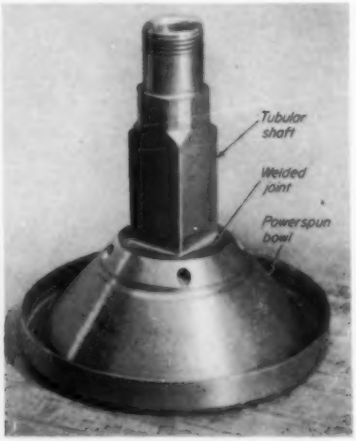


Fig. 6—Centrifuge bowl made of stainless steel type 302 is drilled and welded to tubular shaft after power spinning. This avoids complicated configurations in the blank piece. Note that the weld is hardly discernible.

Fig. 7 — Curvilinear shapes such as housing cover in (A) can be power spun with a gradual thinning wall, as shown in (B). Details *A* and *B* show computations for determining thickness at various sections.

Fig. 7 (A)

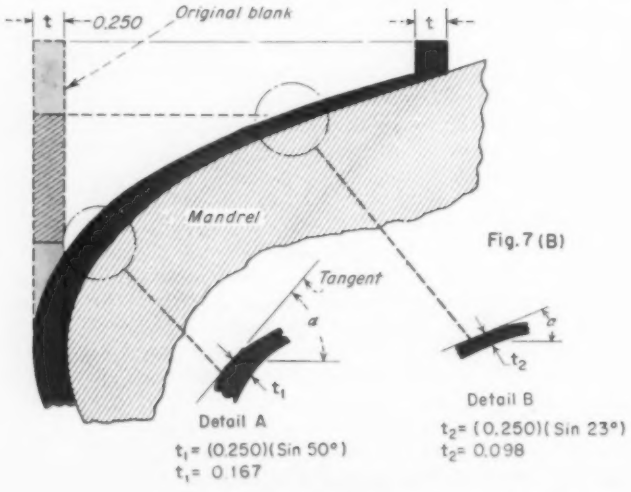


Fig. 7 (B)

Fig. 8—Nozzle with venturi section requires split mandrel to remove part after power spinning. Initial blank made of welded 4130 steel tube 16 in. total height. Four passes required to neck down from 9.5 in. to 3.25 in. Stress relieving of blank not required between passes.

Fig. 9—Flash-welded ring 13 in. I.D. by 10 in. long is power spun to a 58 in. long tube. Material: 4130 steel. Wall thickness before spinning: $\frac{1}{4}$ in.; after spinning: 0.065±0.003 in. thick.

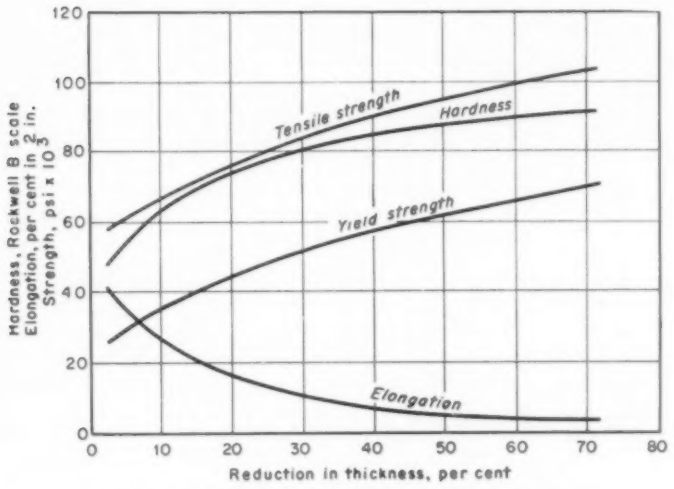


Fig. 10—Change in mechanical properties of Muntz metal as a function of per cent reduction of thickness.

tion in thickness; Fig. 10 shows a typical reduction curve for Muntz metal. Note that at 70 per cent reduction the tensile strength increased approximately 100 per cent, surface hardness 120 per cent, and yield strength (apparent elastic limit) 180 per cent. These increases are accompanied by a drop in elongation which can be partially recovered by heat treating after power spinning. It may be necessary, however, to put heat-treated parts back on the mandrel and lightly power spin to remove possible warpage.

Approximate changes in physical properties of 2S aluminum, SAE 1030 and 4130 steel, and 302 stainless steel are given in Tables I and II. Because data are not available as to the exact number and conditions of the tests, the figures should be used as a guide only.

Most hard-to-work metals, such as the 300 and 400 stainless steels, Timken 16-25-6 and 17-22S, Haynes Multimet, Uniloy 19-9, Inconel and K Monel, offer no difficulty in power spinning. There are reports, however, that titanium should be heated to 1100 F and spun while hot if a high reduction in cross section is desired.

Effect on Fatigue Strength

All indications are that power spinning significantly increases the fatigue of metals. Increase seems to be the result of both the smoothness of the spun surface, which is burnished rather than cut, plus increase in surface hardness. A recent investigation studied the effect on fatigue strength of various types of finishes including cold-rolled, rough-machined, machined and mechanically pol-

Table I—Mechanical Properties of 2S Aluminum Before and After Power Spinning

Cone angle, 30 deg; $\frac{3}{8}$ in. stock reduced 70 per cent

Sample	Tensile Strength, psi	Elongation, per cent	Hardness, Rockwell 15T Scale	
			Outer Surface	Inner Surface
Before Spinning	18,000	22	49-51	49-50
After Spinning	23,000	8	58-62	56-58

ished, electropolished, and ground surfaces. Through use of microhardness measuring techniques it was found that different finishing methods introduced varying degrees and depths of hardness in the surface layers of metals. Cold-rolling produced the highest hardness while grinding gave the lowest value. In addition, the fatigue strength for lifetimes exceeding 2 x 10^7 cycles varied with hardness of surface layer—the highest hardness corresponding to greatest fatigue strength. Smoothness of surface was also found to increase fatigue resistance, although to a lesser degree; notch sensitivity of a metal in fatigue varied with surface preparation. (For a complete report see, "Effect of Surface Finish on the Fatigue Strength of Titanium Alloys" paper No. 55-A-197 presented at the 1955 ASME Annual Meeting.) Since power spinning is essentially a cold rolling process, this study indicates that the fatigue strength of power spun metals should be substantially increased.

Tolerances and Finish

Tolerances on power spun products are a function of: tolerances of the mandrel, concentricity of the mandrel with reference to the centerline of the machine, and set-up position of the rollers. All can be corrected to give close tolerances to the product; the corrections, of course will increase the set-up time and therefore the final cost of the product.

Typical tolerances that can be held without excessive difficulty are: ±0.002 in. on wall thickness; ±0.002 in. on inside diameters up to 6 in. dia; ±0.003 in. on inside diameters over 6 in. dia; ±0.005 on length.

Quality of finish depends upon material, rate of feed of the rollers, and type of operation. A very fine surface finish of 6-8 micro-in. is commonly obtainable for tubes; 16 micro-in. for cones and hemispheric and elliptical shapes. Feeds range from 0.005 to 0.150 in./rev depending on material and desired finish.

Table II—Mechanical Properties of Steel Before and After Power Spinning

	Rockwell Hardness	Yield Strength psi	Tensile Strength psi
1030 Steel			
Before Spinning	B-42	35,000	70,000
After Spinning	C-20	60,000	85,000
4130 Steel			
Before Spinning	B-90	60,000	90,000
After Spinning	C-32	130,000	145,000
302 Stainless			
Before Spinning	B-74	32,000	80,000
After Spinning	C-30	49,000	98,000

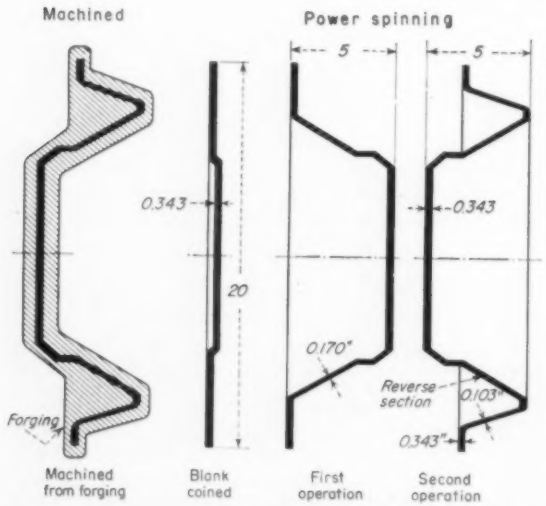


Fig. 11—Bearing housing, formerly machined from a forging, is power spun in two operations from a coined blank. Total cost was $5,000 for two mandrels.

Material Flaws

Power spinning acts as its own inspector. The progressive shift of metal exposes most of the gas pockets or slag inclusions. Inclusions of dirt or slag in the metal will also cause cracks to appear in the surface of the product during spinning. Deep machining marks in the blank, however, do not cause cracking unless severely spun.

Tests conducted by General Electric indicate that for expensive parts it may be desirable to call for vacuum-melted metals to insure sound blanks. This is especially true of titanium alloys.

Welded joints are automatically improved by being plastically deformed during spinning. Spinning relieves stresses incurred during welding and makes the joint less noticeable. In addition, joints incorrectly welded will split during spinning.

Tooling Costs

For short production runs, power spinning is more economical than deep drawing or forging. Spinning does not need two dies (male and female) as required for deep drawing.

Mandrels are usually made of cast iron or tool steel hardened, drawn, ground and polished. Any imperfection in the mandrel surface is reproduced on the final product.

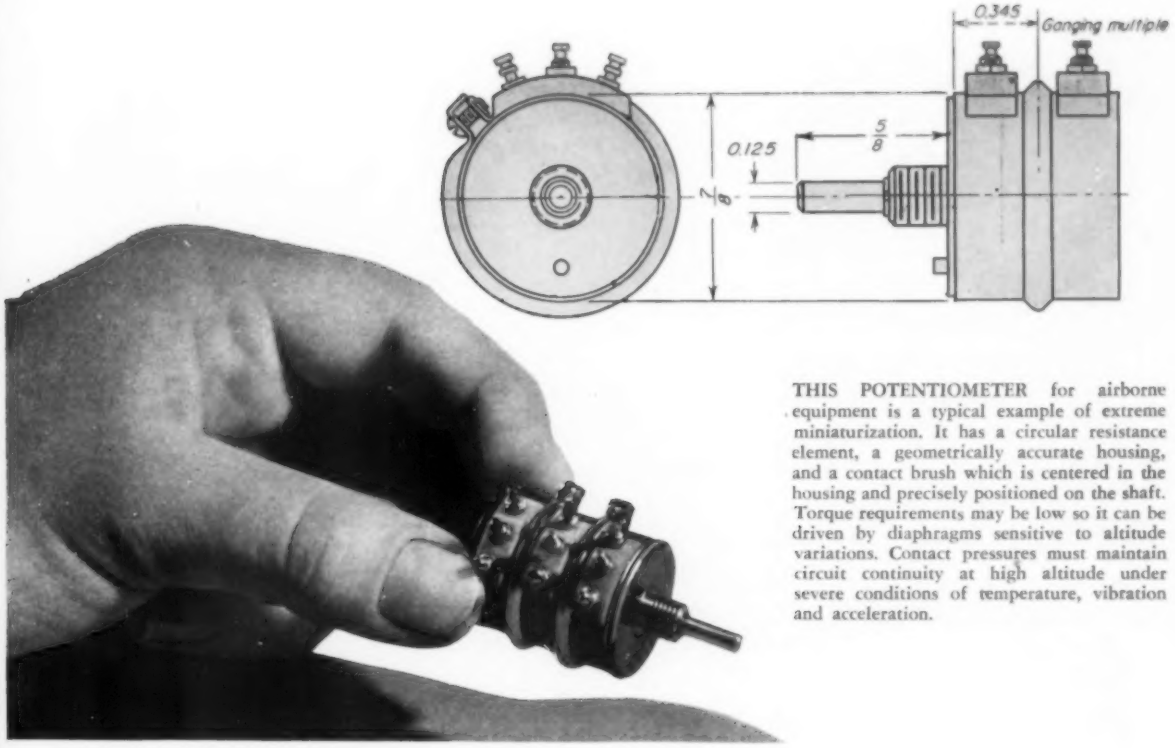
Some typical tooling prices are: $1,000 for a part with overall dimensions 10 in. dia by 5 in. deep; $2,400 for a part 50 in. dia by 16 in. deep; $5,000 for two mandrels to fabricate the housing illustrated in Fig. 11.

Where close tolerances are not a prime requirement, mandrels are sometimes made of hard wood, or a metal-faced wooden core to cut tooling costs.

ACKNOWLEDGMENTS

Product Engineering is indebted to the following sources for their fine cooperation during preparation of this article:

- *Process Machine Division, The Cincinnati Milling Machine Co.*, Cincinnati, Ohio: Don Vancil, V. P. and Mgr.; Robert A. Winblad, Chief Engr.; John McCormack, Estimating Engr.; and Richard Paulton, Supervisor, Design Dept.
- *Floturn Division, The Lodge & Shipley Co.*, Cincinnati, Ohio; Claus Sporck, Manager.
- *The De Laval Separator Co.*, Poughkeepsie, N. Y.: Andrew E. Merget, Chief Chemist & Metallurgist; Clyde R. Purdy, Plant Superintendent; Ralph E. Williams, Works Mgr.
- *Kaiser Metal Products, Inc.*, Bristol, Penna.: Pamphlet "Hydro-spin" prepared by Dale Smith.



THIS POTENTIOMETER for airborne equipment is a typical example of extreme miniaturization. It has a circular resistance element, a geometrically accurate housing, and a contact brush which is centered in the housing and precisely positioned on the shaft. Torque requirements may be low so it can be driven by diaphragms sensitive to altitude variations. Contact pressures must maintain circuit continuity at high altitude under severe conditions of temperature, vibration and acceleration.

Mechanical Problems in MINIATURIZING Potentiometers

Typical design suggestions for precision contacts, insulating and fastening parts, and bearing components.

EDWIN W. DREWITZ
Design Engineer,
DeJur Amsco Corporation

DESIGN PROBLEMS involved in miniaturizing components such as potentiometers are associated with contact design, terminal connections, insulation, bearings, and seals. Decreased size makes tolerances proportionately tighter; new fields of use impose greater acceleration and vibration forces. With less space available to package parts, new design approaches must be developed.

CONTACTS. Contact design and choice of material is one of the primary considerations in designing any electromechanical component, and getting sufficient contact pressure in limited space is one of the first hurdles in miniaturization.

One type of contact is shown at (A) in Fig. 1. Noncorrosive cold worked wire is used as a dual spring contact to wipe a rotating slip ring. Wire is a high gold content alloy of 0.005 in. dia. or smaller. This one-piece contact may be led directly through an insulating housing; a

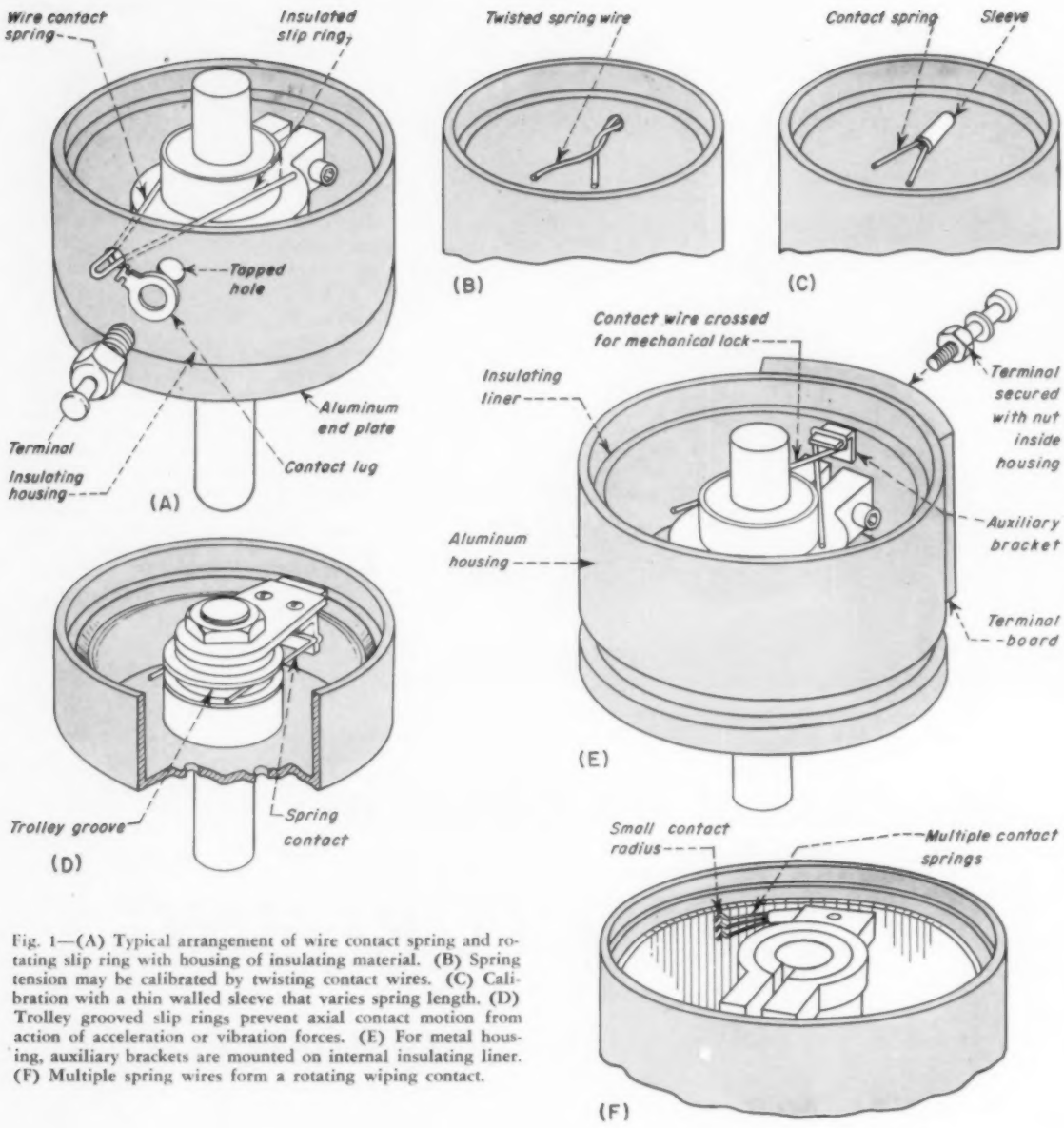


Fig. 1—(A) Typical arrangement of wire contact spring and rotating slip ring with housing of insulating material. (B) Spring tension may be calibrated by twisting contact wires. (C) Calibration with a thin walled sleeve that varies spring length. (D) Trolley grooved slip rings prevent axial contact motion from action of acceleration or vibration forces. (E) For metal housing, auxiliary brackets are mounted on internal insulating liner. (F) Multiple spring wires form a rotating wiping contact.

contact lug placed between the housing and a terminal screw holds the spring in position. Contact pressure is a function of wire dia, spring length and diameter of slip ring.

Pressure may be set by twisting the spring wires as in (B) or by varying the spring length with thin walled sleeves as in (C).

An auxiliary bracket mounted on the internal insulation is required for metallic housings. This arrangement is indicated in (E). The wire is crossed to make a rigid connection to the bracket and twisting would be used to adjust contact pressure. An external, turret type terminal is fastened to the bracket with a nut.

Dual springs will maintain contact during severe lateral vibrations. For resistance to axial vibration and acceleration forces, trolley grooves are machined in the slip rings. This holds the wires in a narrow band as shown in (D). This arrangement has rotatable spring contacts and a stationary slip ring.

For multiple-brush rotating contacts, wires are welded or soldered to a small bracket and formed to required curvature. For best accuracy, forming is done with all components mounted on the shaft, with the shaft acting as a locating plug in the forming fixture. This construction is illustrated at (F).

TERMINAL CONNECTIONS. Some designs have resistance elements wound to 359 deg $\pm\frac{1}{2}$ deg. Making and

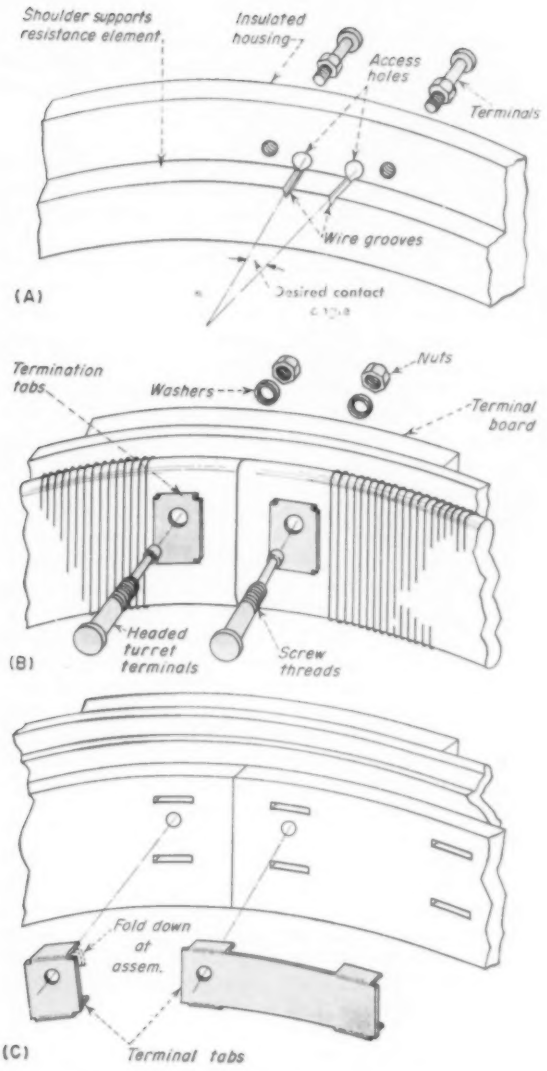


Fig. 2—(A) Lead wires may be set in grooves for pressure contact with resistance element. (B) Turret terminals act as contacts and fasteners for flat resistance element. (C) Tabs folded through slots are a mechanical lock for cemented over-travel termination tabs.

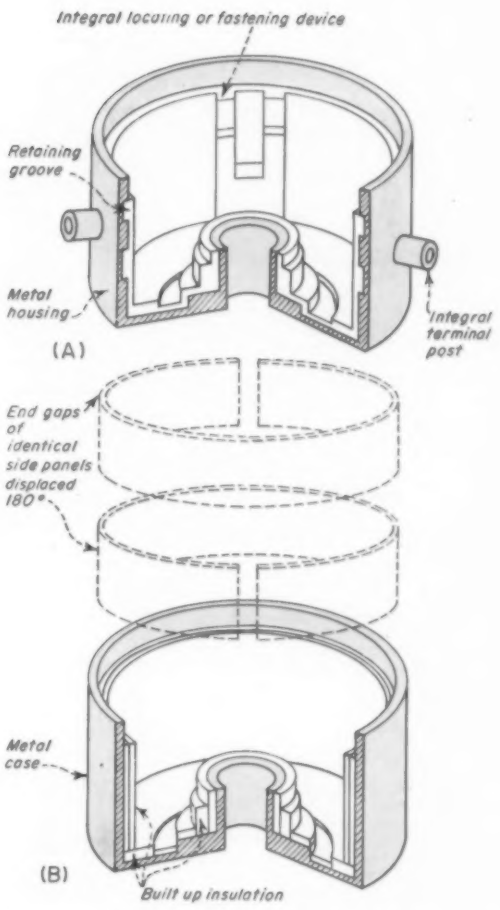


Fig. 3—Insulating material can be molded inside metal shell for production quantities, as at top, or built up insulation assemblies can be used for small quantities.

maintaining accurately positioned contacts with such an element is a difficult problem. One method is welding wires to the desired turn. As leads may be of wire 0.0011 in. dia, this is a slow operation that needs talented operators, special fixtures and optical viewers. The process of "tap welding" is often the only practical solution when pressure contacts cannot be used.

If pressure contacts can be used, they may be accurately installed as shown at (A) in Fig. 2. Grooves are positioned at the desired contact angle in the shoulder that holds the resistance element. Grooves are cut so the contact wire will press against the element after assembly; the contact wires are secured to external terminals which are either pressed or screwed in the insulating housing.

Terminal connections to flat card elements are simplified by method used in (B). Headed turret terminal acts as fastener and contact. Head end contacts a precious metal overtravel termination tab; a nut and lockwasher holds the unit in place. This is stronger than lead wire connections and is also suited to rotary switches.

Overtravel tabs can often be cemented in place. As this does not give a mechanical fastening, ears may be folded through slots to obtain a mechanical lock. This method is shown at (C). The slots make an accurate reference for assembly.

INSULATION. Housings which are insulators simplify design but a need for greater strength, more heat dissipation, or plated finishes may require metallic housings. This raises the question of proper insulation.

Insulated housings serve as their own terminal board, but metallic housings require both internal and terminal insulation. For production quantities, the insulating material may be molded directly inside the shell. This makes possible complex design features such as the shoulders,

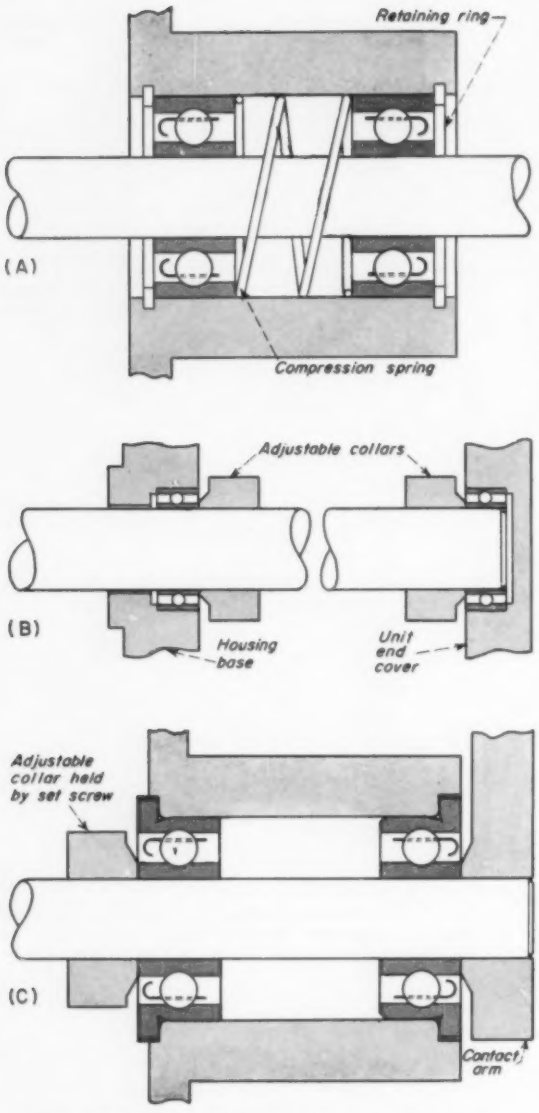


Fig. 4—(A) Compression spring holds outer races against retaining rings; shaft is light push fit in inner races. (B) Placing bearings in cover and base of housing gives maximum shaft stability. (C) Flanged bearings can be held against shoulders by collars and contact arms.

bosses, and terminal posts shown at (A) in Fig. 3. For small quantities, the required insulation can be built up with fabricated tubes, washers or strips as shown in (B) with satisfactory results.

Components must often be dipped or otherwise coated to inhibit fungus growth, and the applied material often changes critical mating dimensions. Selection of XXX-P grade laminated phenolics for fabricated flat parts and XX-10 grade for tubular parts makes coating unnecessary. Nylon base materials are recommended where extreme strength and toughness are required; they also do not require coating. Molding materials such as mineral filled melamines have similar fungus resistant properties and may be used with the method indicated at (A); grade BM17748 Bakelite can be used for greater dimensional stability.

BEARINGS. Axial or radial shaft motion moves brushes relative to windings, causing erratic variations in electrical characteristics. This is prevented by rigidly supportng miniature shafts on ball bearings.

There are many ways to support potentiometer shafts with miniature ball bearings but two radial bearings are nearly always used at each end. The method of removing internal play in radial bearings depends on housing design and available space. Inner and outer races are always individually restrained to prevent motion, but not enough to increase friction torque by excessive preloading. Fig. 4 (A) shows outer races held by retaining rings while a spring spaces the bearings. Shaft is positioned by a light push fit in the inner races.

The plan used at (B) gives maximum shaft stability by placing bearings in the cover and base of the housing. Outer races are a light press fit against counterbored shoulders. Adjustable collars held by set screws preload the inner races to prevent radial bearing play.

Method (C) in Fig. 4 is recommended when internal or external drive cranks are required. Flanged bearings set against counterbored shoulders in the housing and inner races are preloaded by a coupling, drive arm or collar. The bearings illustrated are available commercially in many sizes with various load and torque ratings. Standard units are available with 0.1 in. O.D. for 0.025 in. dia shafts. Super-light bearings are made for limited mounting space.

Low starting and running torques are obtained with radial retainer and spring separator bearings because they have fewer rolling elements. Load capacity is also reduced. Spring separator units are useful for oscillating motion where low starting torque and a damping effect are essential. Almost all sizes and types may be specified with built-in dirt shields.

SEALS. Use of an "0" ring seal is shown in Fig. 5. A recess cut in a sleeve bearing holds the ring; the edge is then spun to form a retainer. A groove in the shaft at the ring position gives added sealing action. The friction torque introduced by the ring can act as a simple clutch to hold shaft settings against shock or vibration forces.

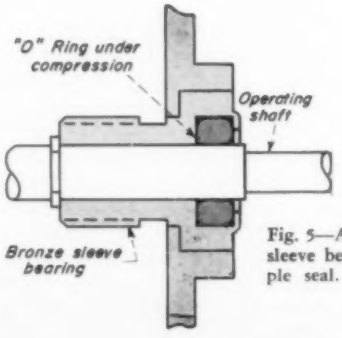
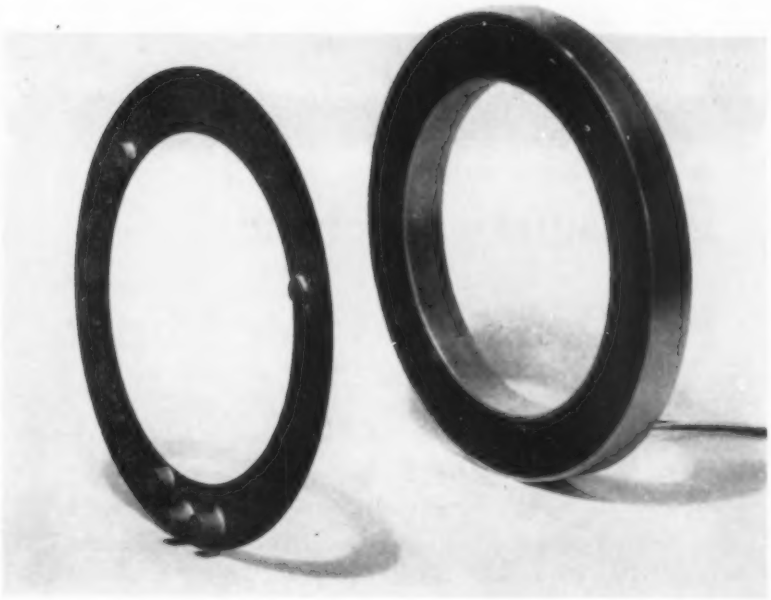
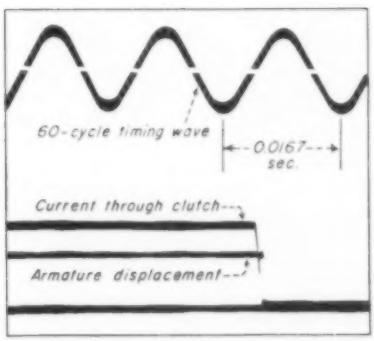


Fig. 5—An "O" ring set in a sleeve bearing makes a simple seal.



Fast Acting Magnetic Clutch

R. E. TOMPKINS and R. F. EDGAR
General Engineering Laboratory
General Electric Company



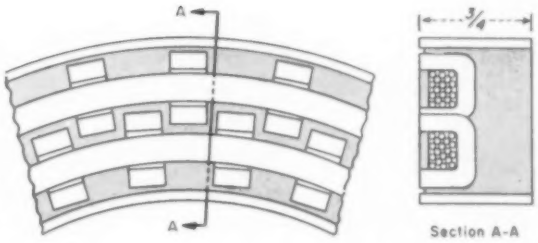
COMPACT QUICK-RELEASE CLUTCH was needed in the form of a thin ring around a 5-in. dia shaft. Available operating power was rectified d-c with control on the a-c side; circuit resistance was limited, and minimum inductance was essential for maximum rate of current decay.

Design develop to meet these conflicting requirements consisted of a magnetic circuit made of laminated C-cores wound of 0.002 in. silicon steel. Armature is a thin solid ring of silicon steel 7 in. dia, designed for adequate rigidity and reasonable flux density.

C-cores are arranged alternately in two concentric circles, with a single magnetizing coil of Alkanex for each circle. Cores and coils are embedded in class H potting compound between brass inner and outer rings; face is then ground flat. Abrasive powder mixed in the plastic increases friction coefficient.

Clutch torque with a 2.5 ohm coil and 3 amp coil current is 10 lb-ft; release time (see oscillogram) is about 0.001 sec. Construction is sturdy enough to take 100 g shock.

In the release-time test shown above, the circuit was



opened by a simple knife switch with current at 87 per cent of rated value. Trace showing clutch opening was energized by a dry cell through a contact on the armature which opened as soon as the armature started to move. In a similar test with current reduced to produce half of rated torque the release time was 0.0025 sec.

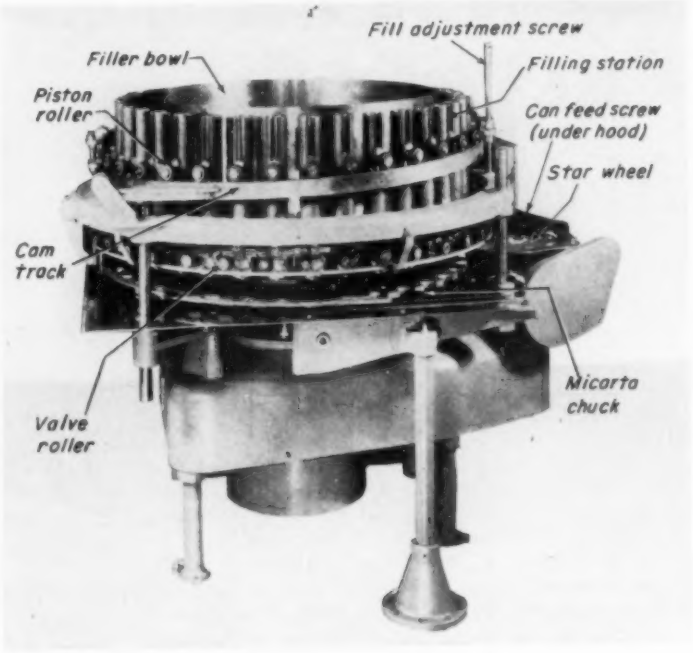
When the clutch was released by short circuiting the coil instead of opening the circuit, current decay was slower; release time was 0.0067 sec. With current reduced to give half of rated torque, time was 0.0078 sec.

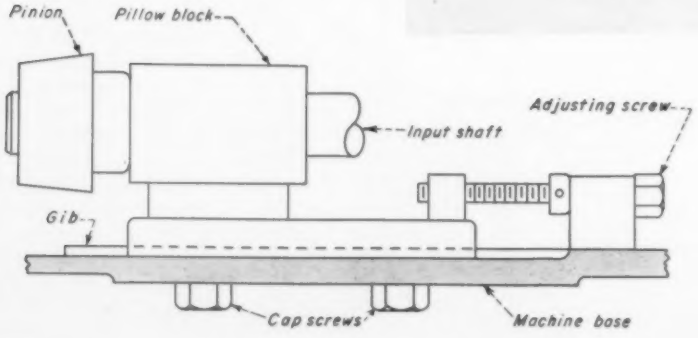
Packaging Machine Fills 1050 Cans Per Minute

A large diameter can-path and tilted can guide rails allow this machine to fill more cans per min than the previous design at the same filling speed per can. The unit also has a no-can, no-fill mechanism, an electric brake and an automatic lubrication system. It was designed under the direction of Joseph Stigler at the Pfaudler Co., Rochester, N. Y.

ROTARY PISTON FILLING MACHINES package viscous or semi-solid products and are driven mechanically by the closing machine, which seals the filled cans, to keep the units synchronized. Cans feed along a screw to a star wheel which positions them in micarta chucks on the filling table. These chucks rotate with the filling stations and discharge filled cans to a straight-line take-off conveyor.

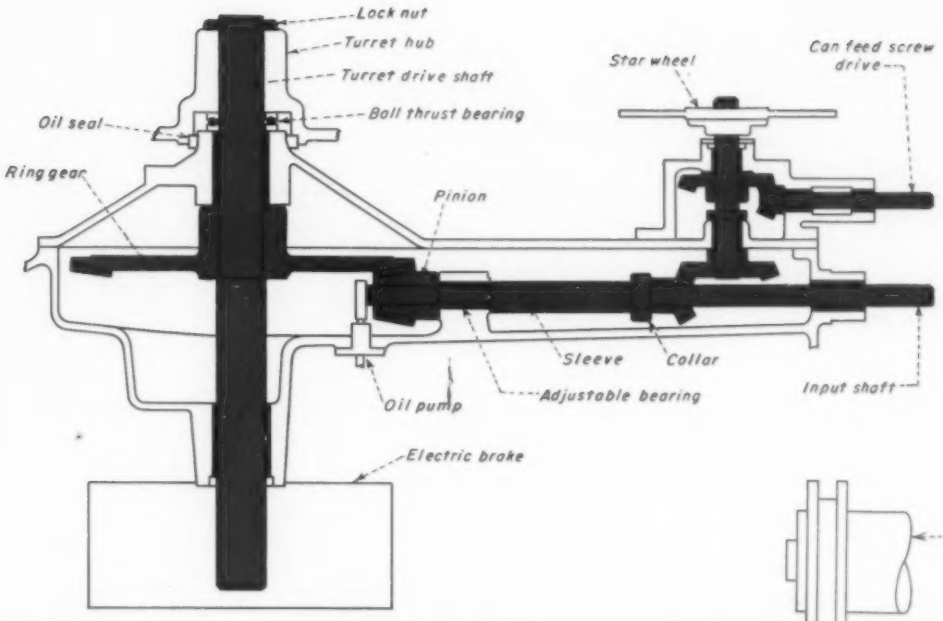
Previous design used 21 stations and filled about 600 cans per min. New machine has a larger diameter bowl and can path to increase output by using 35 filling stations. This holds constant the speed at which each can is filled but requires tilting can guide rails to prevent spilling from angular acceleration of the product.



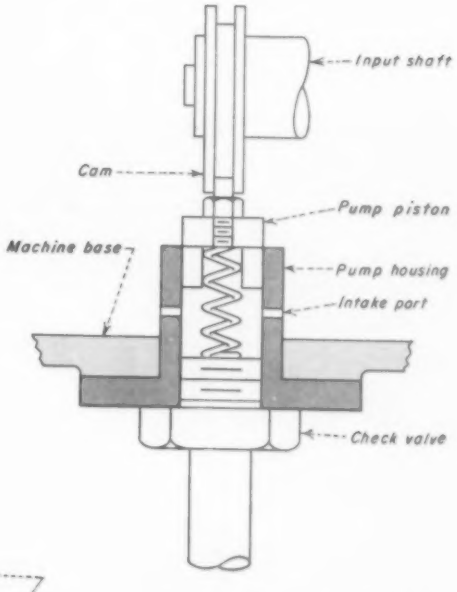


CONSTRUCTION of adjustable bearing on input shaft. Pillow block is held to the base by 4 cap screws in slotted holes that allow axial motion. It is slotted to slide on a gib machined in the base casting. Adjustment of backlash between gears of turret drive is made with cap screw mounted in lug attached to base. Tapped lug on sliding plate serves as a nut.

IN NEW PRODUCTS



POWER FOR ALL DRIVEN ELEMENTS is taken from a single input shaft in the base. The cast iron base and cover are assembled before bearing housings are bored for vertical shaft of the filling turret. As input shaft rotates below 300 rpm, bronze bushings are used as bearings at all points except the filling turret; turret is supported on a thrust ball bearing. The bevel gear that drives the turret ring gear is mounted on a splined section of the input shaft and is positioned axially to remove backlash; a sleeve and collar are used to remove backlash in star-wheel drive in the same way. The can feed screw is driven from the star-wheel shaft.



OIL LEVEL in machine base is held above input shaft so bevel gears for filling turret and star-wheel drives are partially immersed. A pump driven by an eccentric cam on the end of the input shaft supplies oil to turret thrust bearing and star-wheel drive. Pump piston is spring loaded against cam. A ball-check is the discharge valve while ports in housing admit oil to pump cylinder.

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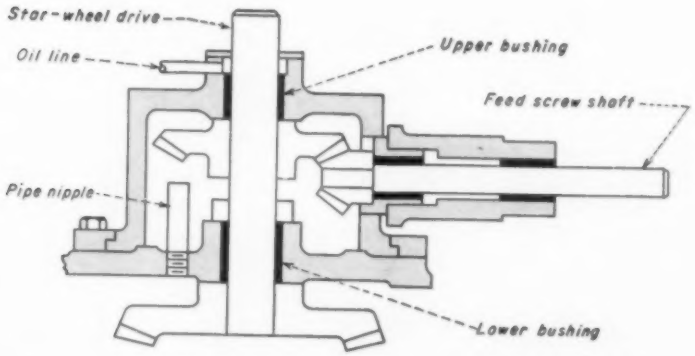
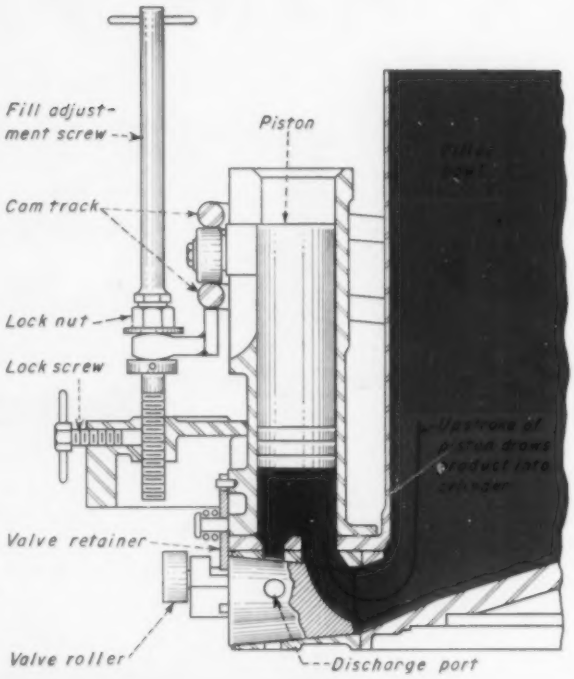


OIL IS PUMPED to top bushing of star-wheel drive and flows through to bevel gear that drives feed screw shaft. A pipe nipple sets oil level to immerse screw shaft pinion and supply oil to lower bushing. A similar chamber holds oil level to lubricate ball thrust bearing and upper bushing of filling turret drive.

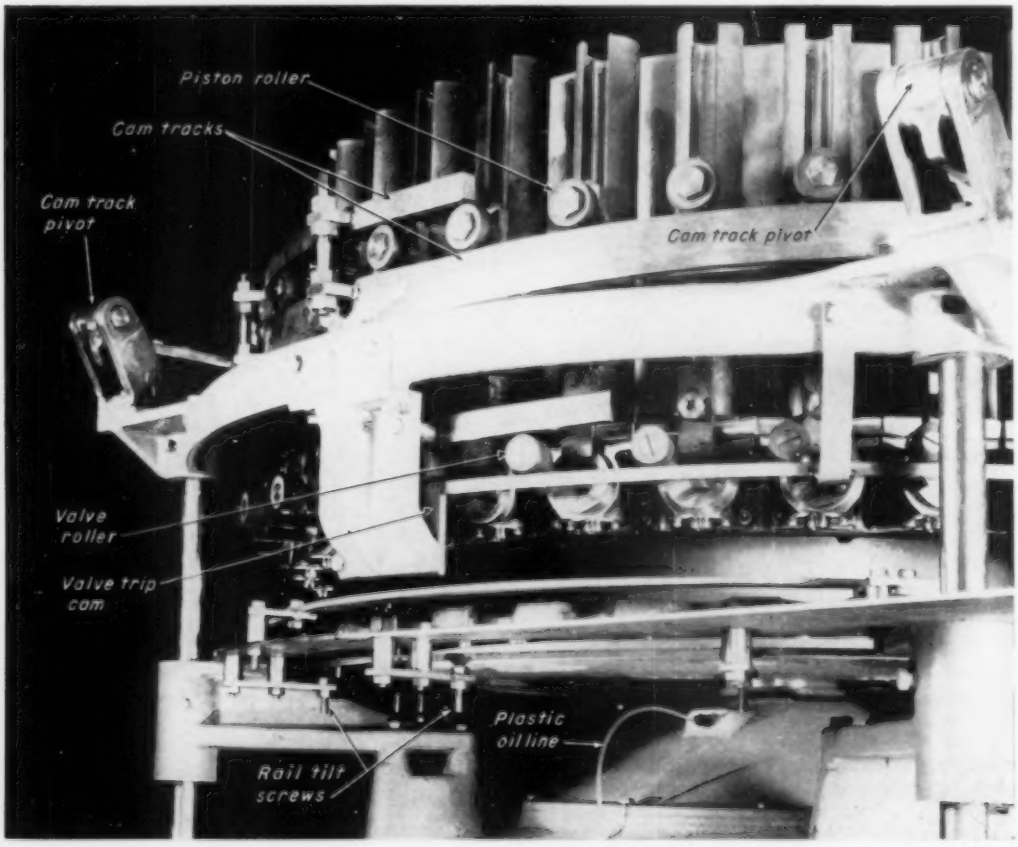
Packaging Machine (continued)

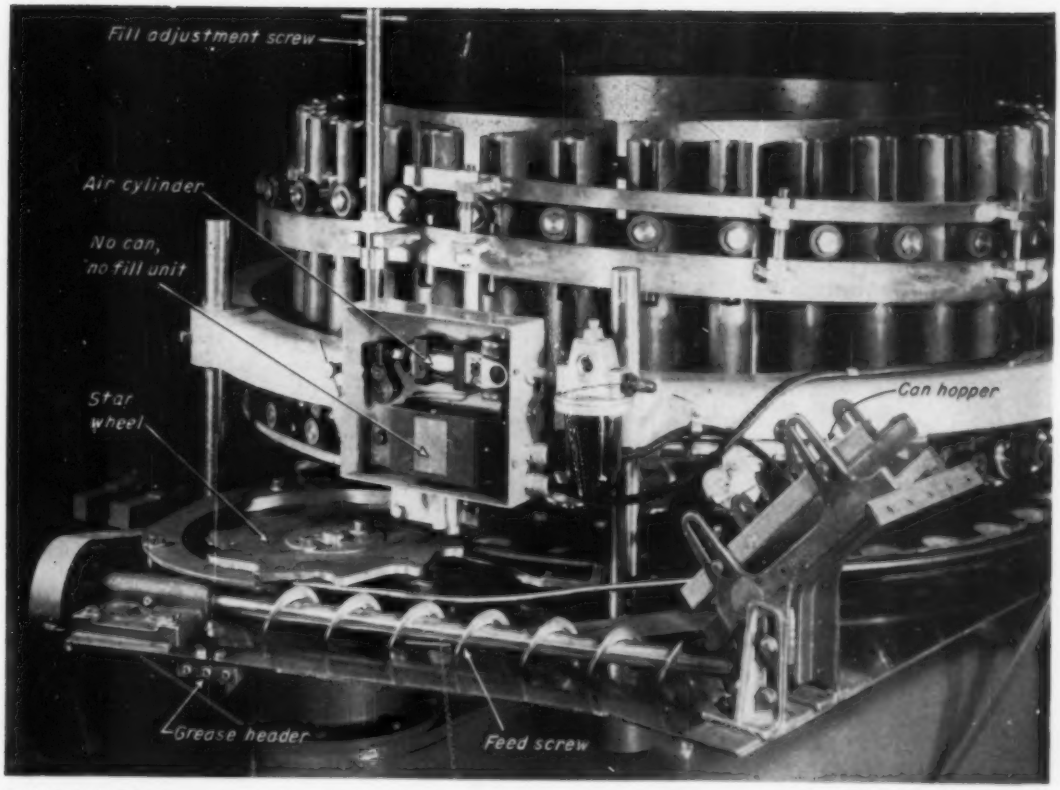
ARRANGEMENT OF BOWL and typical filling station of the rotating turret during intake stroke of the piston. A roller attached to each piston rides between two cam tracks which raise and lower it as turret rotates. Trip cams position the valves in sequence to fill and discharge cylinders. The plug valves are held in place by a spring loaded retaining finger. Piston stroke is changed by fill adjustment screw which sets cam track for maximum rise in cylinder. Dome shaped bowl bottom facilitates cleaning. Pistons and plug valves are easily removed.



PISTON CAM TRACK is supported at 3 points. The filling adjustment screw supports the high end and two pivots support the low end. These pivots are mounted on extension bars so their axis is tangent to lower end of the track. This prevents changing low point of piston travel by resetting fill adjustment screw. Rollers contact lower track during intake stroke and upper track during discharge stroke. Note position of trip cam which resets plug valve for intake stroke, and plastic oil line to turret thrust bearing.

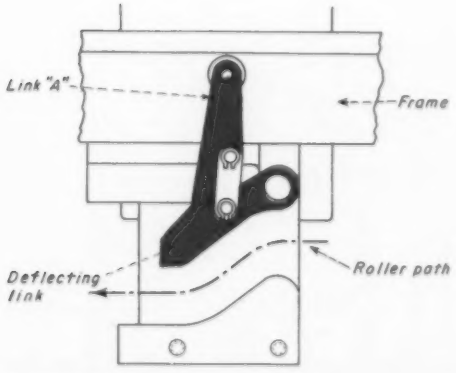
Cans are tilted by lowering inner can guide rail with the screw adjustment shown. Amount of tilt required varies with product viscosity and rpm of turret.



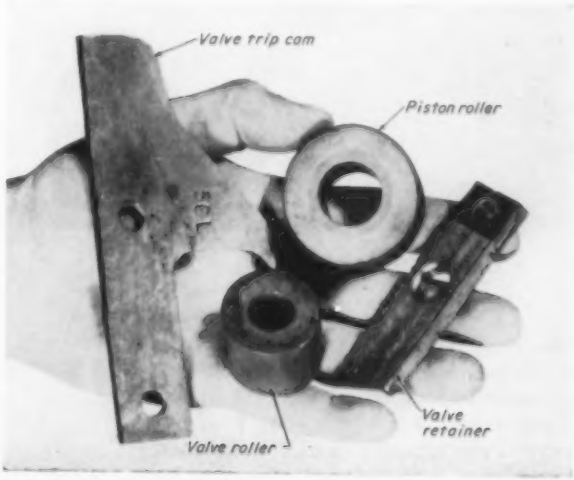


FEED SCREW spaces cans and synchronizes their motion with star-wheel rotation. Grease is piped from a header placed beneath the feed table to 3 points not lubricated by the oil pump. Filling station cylinders are stainless steel while pistons and valve plugs are made from a nickel alloy.

As the cans start around the filling table in the micarta chucks, they pass a sensing finger which triggers the no-can, no-fill mechanism if an empty chuck goes by.



NO-CAN, NO-FILL MECHANISM in normal operating position. As turret rotates, valve cam rollers enter from right side and are deflected downward to open position. When finger on table senses empty chuck, it energizes air cylinder which rotates link (A) clockwise to lift deflecting link from roller path. Valve of filling station without can stays closed until chuck receives can on next cycle.



ONLY 4 WEARING PARTS need periodic replacement: valve trip cam, piston cam roller, valve roller and valve retaining finger. The trip cam and valve roller are made of hardened nitroloy. The piston roller is machined laminated phenolic plastic, and the steel valve retaining finger has a micarta wear pad.

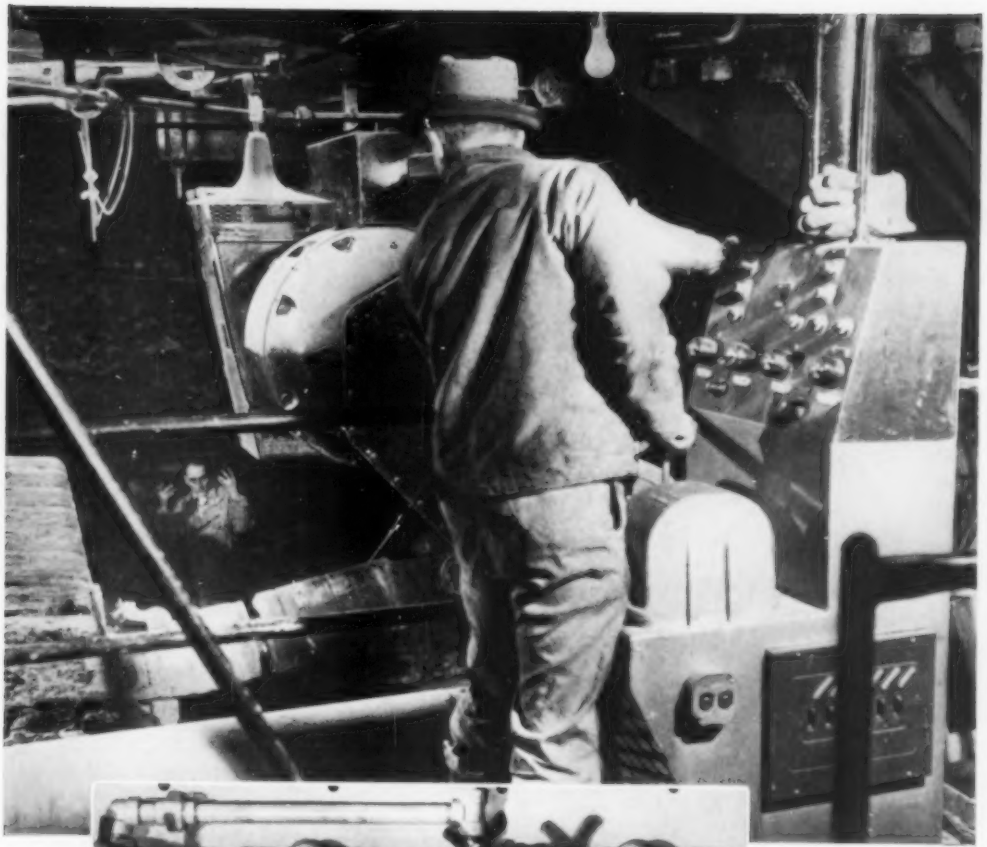
STRIPPING SHOVEL with four separate crawlers and their associated pistons and cylinders. Special heavy chevron packings are used to seal continuous pressures of 2000 psi and intermittent pressures of 2500 psi. Cylinders are welded to the lower frame and stiffening webs welded around the cylinders. (See May 1956 page 148 for discussion of structural designs of frame.)

Hydraulic Leveling

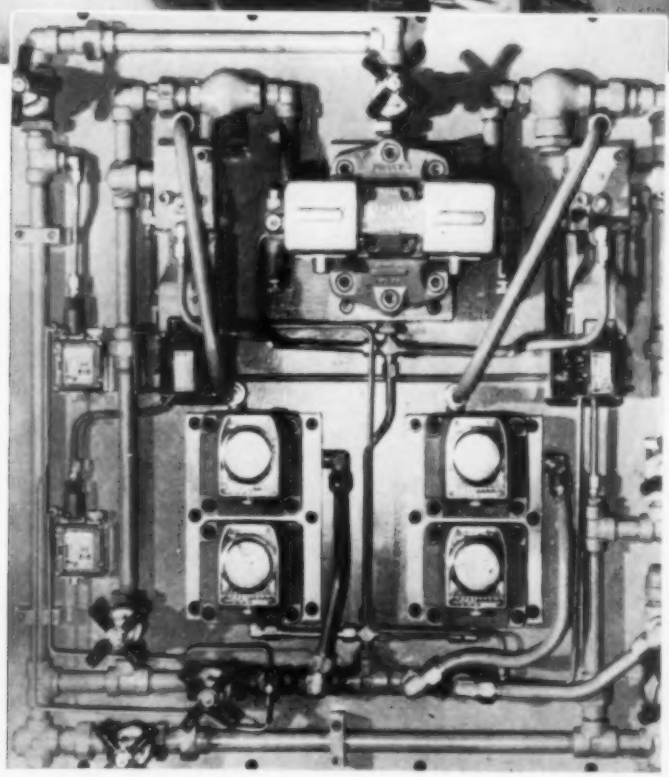
Excessive strains imposed on structural members by unequal load distribution are eliminated by the automatic leveling system installed on large stripping shovels manufactured by Marion Power Shovel Company. Four separate crawler units are fitted with pistons that enter hydraulic cylinders in the lower frame, one at each corner. Oil is forced into the cylinders at high pressure to support the weight of the entire superstructure. By controlling the flow of oil into and out of the various cylinders the main deck can be leveled in any desired position within the limits of cylinder travel.

When traveling, load is equalized by leaving the rear two cylinders locked and interconnecting the two front cylinders. Three point support (the rear two crawlers plus the mean of the front two crawlers) limits frame stresses when traveling over rough terrain.

When standing, diagonally opposed cylinders are automatically levelled by pumping oil into low cylinder and metering same volume from opposite member.

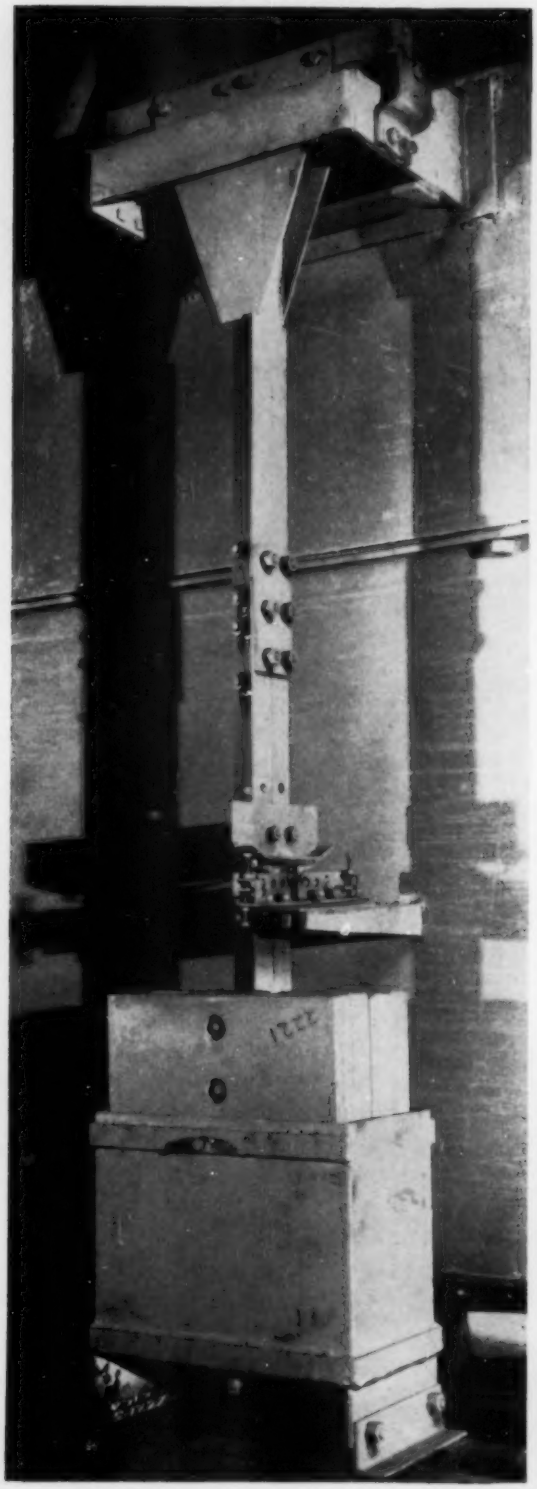


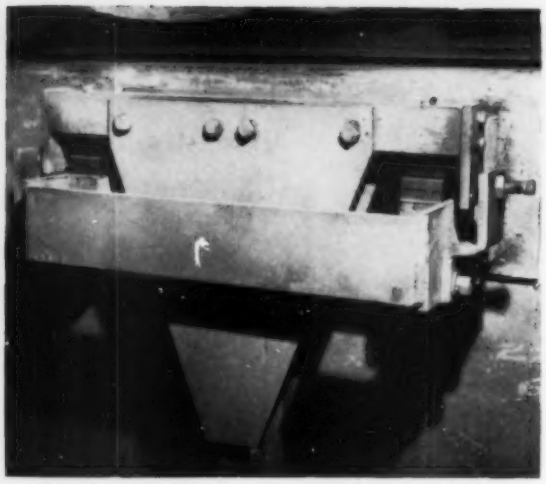
▲ AT THE CONTROL STATION for the crawler drive, all four corners can be raised or lowered as desired. Limit switches on each cylinder stop pumps when allowable travel has been reached and light a red warning light when any corner is too high or too low.



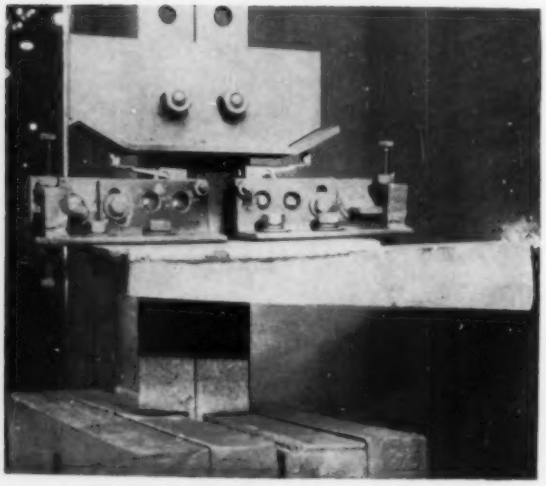
◀ CLOSE-UP OF VALVE CONTROL PANEL. Two are included in each machine and all valves except equalizing valve are mounted here for easy repair and maintenance. Double solenoid valve is top center, flow control valves below.

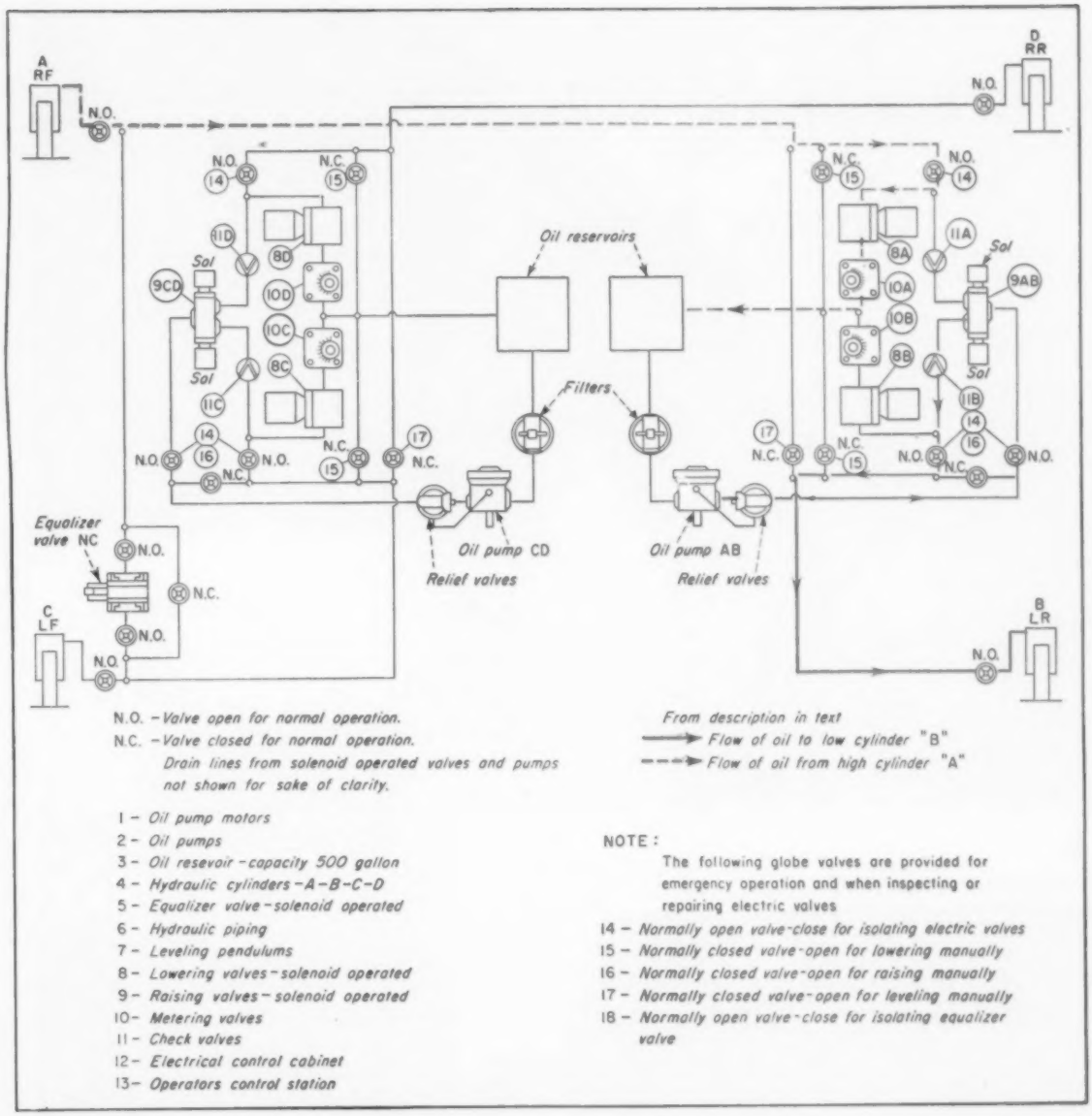
(continued on next page)





PENDULUMS CONTROL solenoid operated valves and pump driving motor when frame is out of level. They swing in diagonal planes, left front–right rear and right front–left rear, and control flow of oil into the low cylinder and out of the high cylinder of each pair. Microswitches actuate a motor starting switch and solenoid operated valves.





N.O. – *Valve open for normal operation.*
N.C. – *Valve closed for normal operation.*
Drain lines from solenoid operated valves and pumps not shown for sake of clarity.

From description in text
Flow of oil to low cylinder "B"
Flow of oil from high cylinder "A"

1 – *Oil pump motors*
2 – *Oil pumps*
3 – *Oil resevoir – capacity 500 gallon*
4 – *Hydraulic cylinders – A–B–C–D*
5 – *Equalizer valve – solenoid operated*
6 – *Hydraulic piping*
7 – *Leveling pendulums*
8 – *Lowering valves – solenoid operated*
9 – *Raising valves – solenoid operated*
10 – *Metering valves*
11 – *Check valves*
12 – *Electrical control cabinet*
13 – *Operators control station*

NOTE:
The following globe valves are provided for emergency operation and when inspecting or repairing electric valves

14 – *Normally open valve – close for isolating electric valves*
15 – *Normally closed valve – open for lowering manually*
16 – *Normally closed valve – open for raising manually*
17 – *Normally closed valve – open for leveling manually*
18 – *Normally open valve – close for isolating equalizer valve*

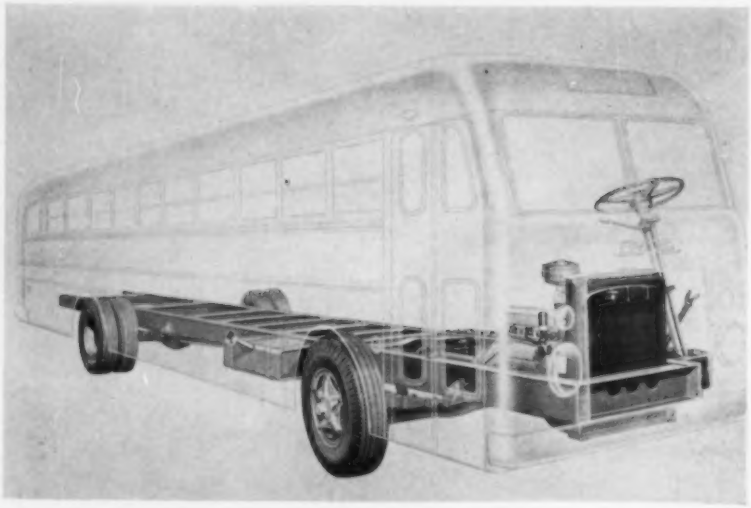
CIRCUIT DIAGRAM with flow directions indicated for an out-of-level condition. Pendulum swings when cylinder *B* is low relative to **A**. Oil pump **AB** is put into action by its electric driving motor. Simultaneously selector valve *9AB* (normally open) has one solenoid energized, closing off the port to cylinder **A** and solenoid valve *8A* (normally closed) is opened. Flow from the pump is forced into cylinder **B**, while oil is metered from cylinder **A** through flow control valve *10A*. The metering valve is adjustable and is set to release oil from the high cylinder at the same speed that oil is pumped into the opposite low cylinder.

When the pendulum swings off the microswitch the pump stops, valve *8A* is closed and valve *9AB* is returned to the open center position. Check valves *11* seal off the cylinders.

For equalization of load during travel, the automatic leveling system is disabled and an equalizing valve (normally closed) is opened. Level of the two rear cylinders remains fixed while oil from the two front cylinders is permitted to interchange, effectively forming a single point support between the two front crawlers about which they pivot.

Bus Engine Rolls Out for Repair

By mounting the engine on a lowered subframe forward of the front wheels, the Truck & Coach Div. of General Motors produced a 72 passenger school bus with a 209 in. wheelbase. Removing engine for servicing makes possible a full length coach body with forward control. Designed under the direction of William J. Craig, Truck Special Equipment Engineer, the unit has a 160 hp engine, hydramatic transmission, and a two speed rear axle.



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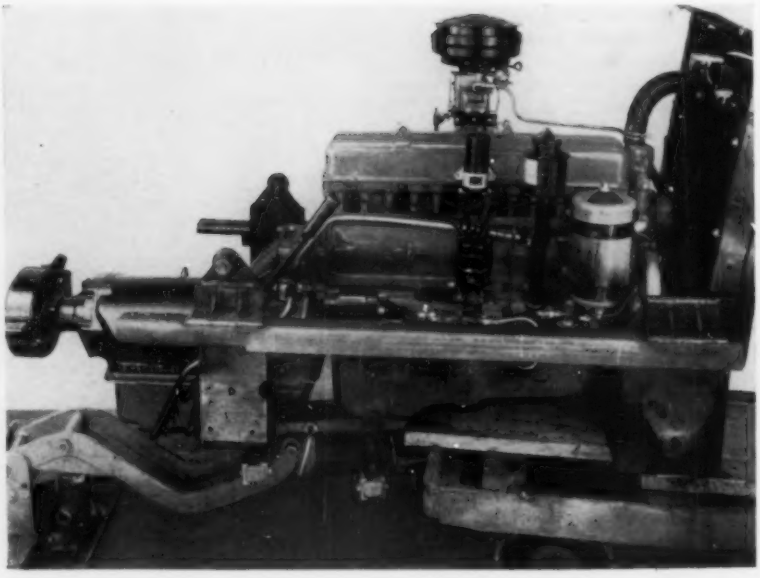
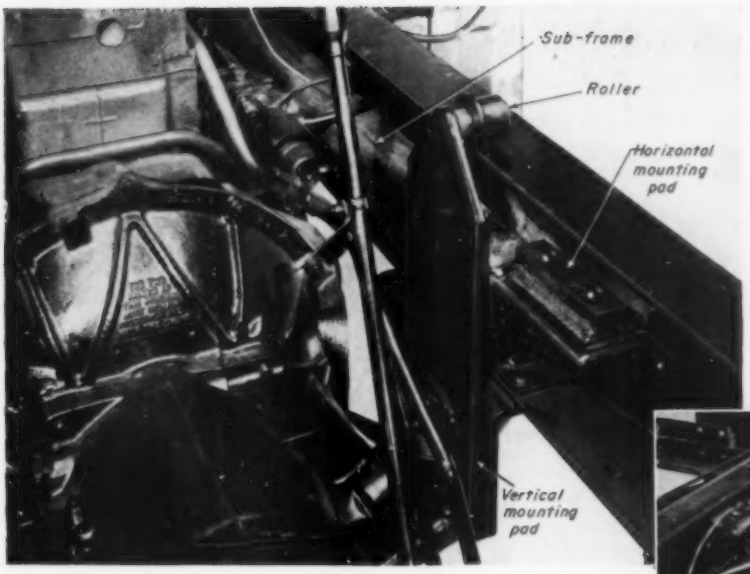
OVERALL LENGTH OF CHASSIS is about 376 in. with the rear half tapered to lower body on rear axle. It is constructed of straight channels and requires no special dies. Wheel base is altered to user's specs by repositioning front axle and cutting off channels. Placing engine and driver forward of front wheels keeps weight distribution approximately equal on both axles with bus loaded or empty. This reduces pitching on uneven roads and makes unit easier to steer.

The bus is designed around existing proven components for dependability and low cost. It uses a standard GMC truck engine and hydramatic transmission with two-speed electrically-shifted Timken rear axle. The one-piece trussed body has no joints subject to failure from continued flexing.

ENGINE, RADIATOR and transmission are removed as one unit. Six cylinder engine has 4 in. bore, 4 in. stroke, 7.5 to 1 compression ratio and develops 160 gross hp at 3800 rpm. A 50 amp generator powers the 12 volt electrical system and charges the 205 amp-hr battery. Sub-frame is test stand for performance checks or jig for disassembly and repair.

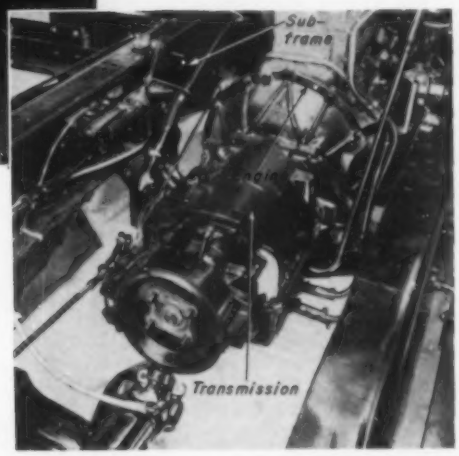
▼

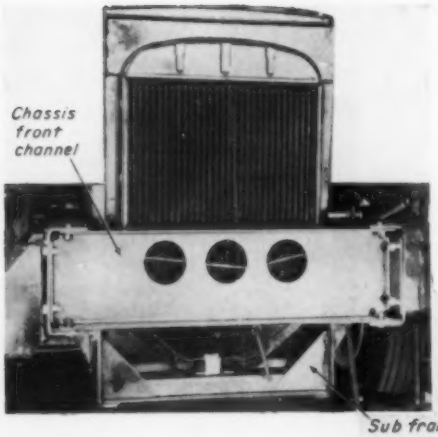




◀

SUB-FRAME SUPPORTS ENGINE 6 in. lower than conventional mounting to give better access to front door and driver's seat. It carries engine and transmission and bolts to main frame at 4 points. Front end of sub-frame is supported during removal; rollers ride main frame to support rear end. Rear mounts have both horizontal and vertical pads so rollers are held above chassis when sub-frame is in operating position.

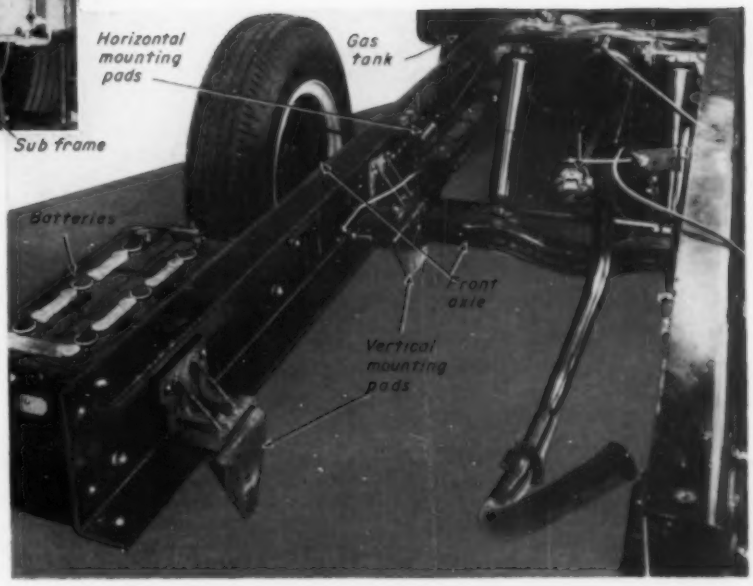




▲

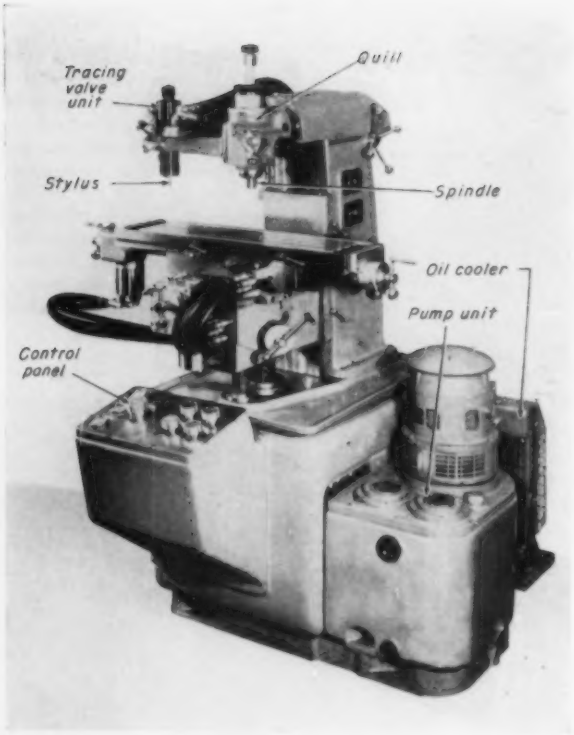
FRONT CHANNEL OF CHASSIS is removable so engine can slide forward. Drive shaft, cable harness, control linkage, and fuel and vacuum lines are held clear of engine assembly when disconnected. Bolts of front pads are removed with dolly beneath frame and rollers at rear drop on chassis when rear pad bolts are taken out.

Front axle is reverse Elliott design with 77 in. track that makes possible a 39 ft turning radius. Springs and steering mechanism are outside of chassis to avoid interference with sub-frame.

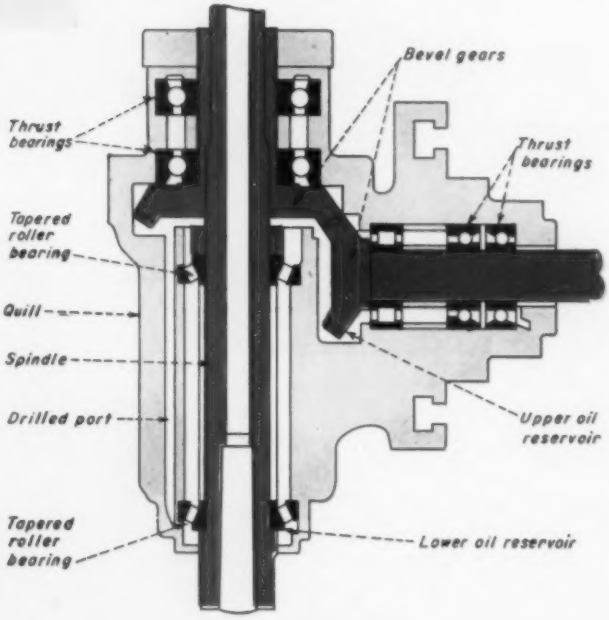


Tracer Valve Controls Milling Machine

One stylus moves two valves to control vertical and horizontal traverse of a profile milling machine developed by Hayes Engineers, Ltd., Leeds, England. Oil temperature is held constant and traverse speed varied with cutting angle for uniform surface cutting feed.



▲ **THIS MACHINE MILLS** 1-to-1 reproductions of 3-dimensional master patterns by positioning knee and table in response to deflections of the tracing stylus. Previous design used one tracing valve that controlled knee motion only; table traverse speed was set manually. New tracing valve gives fully automatic action by controlling both drives to hold constant cutting feed speed on all contours. Hydraulic system is powered by a motor driven duplex pump mounted inside the oil tank. Note oil cooler behind pumping unit.

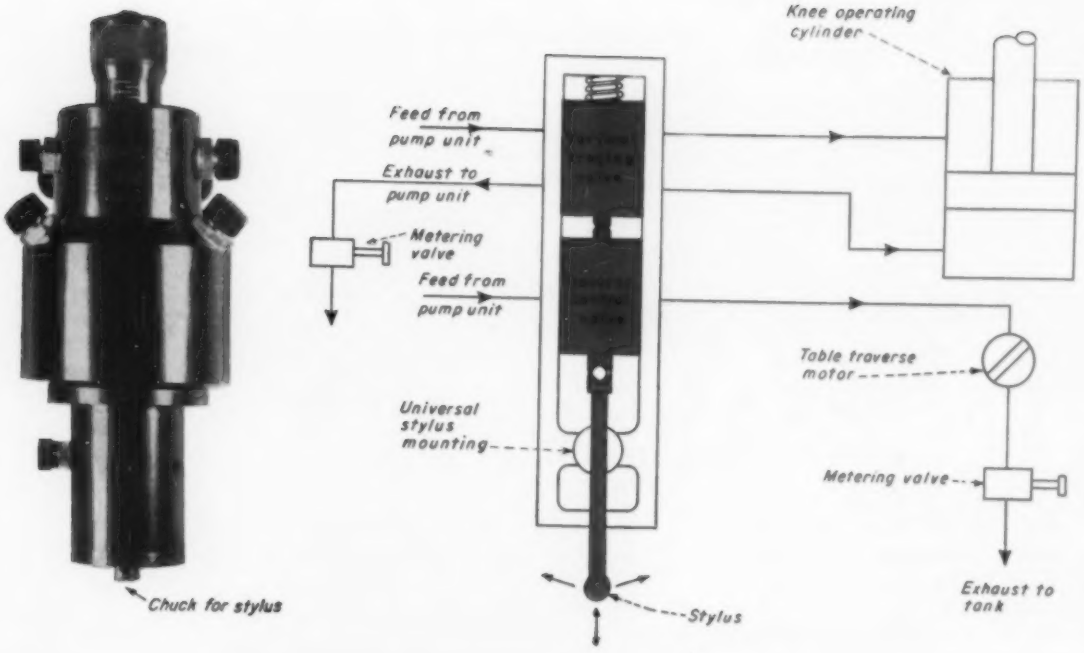


▶ **SWIVEL HEAD SPINDLE** is driven by spiral bevel gears and supported on tapered roller bearings; both gears have dual thrust bearings. As head turns through 180 deg angle, a lubrication method was selected that works in all positions.

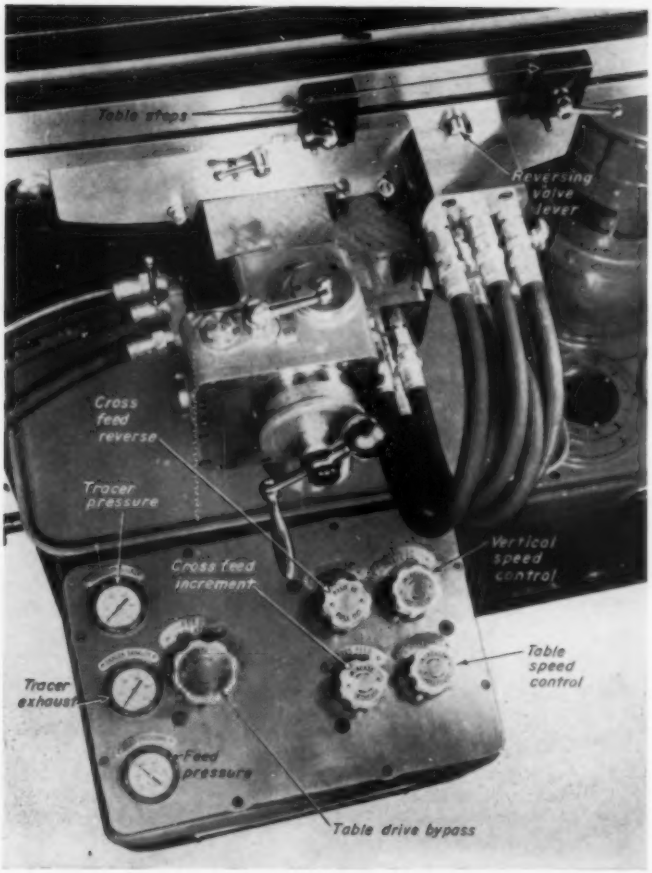
Gear and bearings on horizontal shaft run in a small reservoir and transfer oil to the gear on the vertical shaft. Agitation makes mist which lubricates thrust bearings on vertical shaft. Top spindle roller bearing is also lubricated by oil from large gear which drains down spindle to lower bearing and reservoir.

At speeds over 1800 rpm, the lower roller bearing pumps oil back to upper bearing through a port drilled in quill. Some of the oil returns to horizontal shaft reservoir and is recirculated. Excess oil overflows lower reservoir and drains down spindle; oil is added through hole in top of head to keep system filled to proper level.

A spinner in the lower reservoir flings the oil back into the bearing to produce constant recirculation.



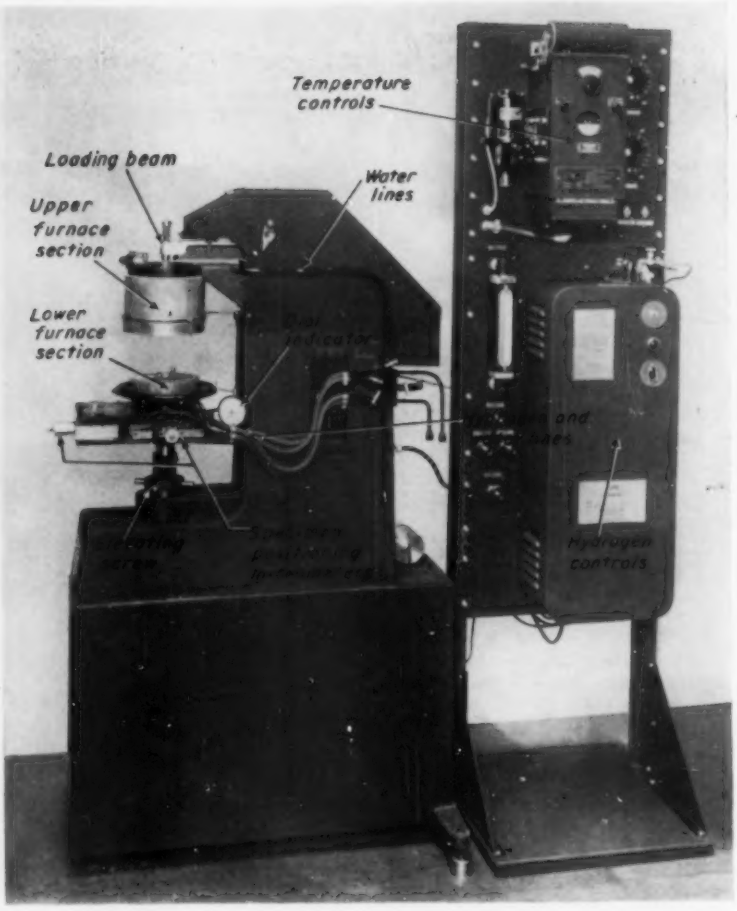
▲ **HYDROTRACER UNIT** contains the two spring loaded control valves positioned by stylus deflection. Stylus is held in ball mount to allow 3-axis motion and exerts less than 1 lb force on master during horizontal cut. Deflecting stylus 0.015 in. stops traverse and drives knee at top speed. Note 45 deg slope of ball socket where stylus connects to valves so any deflection decreases traverse speed and increases proper vertical knee speed. Setting metering valves for equal maximum speeds for knee and traverse motions gives constant cutting feed speed on all contours.



◀ **HYDRAULIC MANUAL CONTROLS** are grouped on panel in front of the machine from which operator can reach all control adjustments. Adjustable stops actuate a servo operated valve to reverse table and move cross slide after each cut. Cross traverse is driven by a fluid motor with direction and speed preset at control panel; increments are variable from 0.005 to 0.250 in.

Hot Hardness Tester

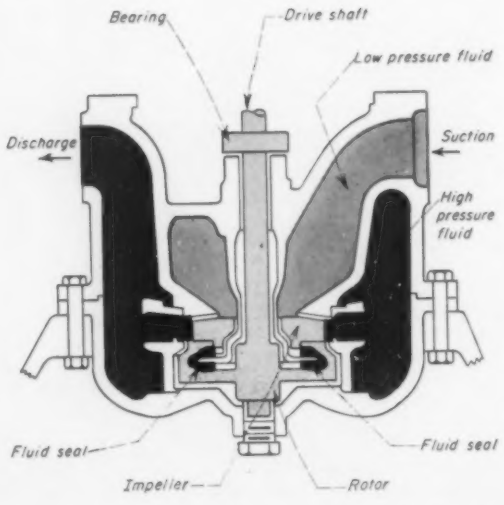
Accurate specimen alignment, light indentor loads, and a controlled atmosphere furnace determine the hardness of film cross-sections 0.0005 in. wide at 1200 deg F. The instrument positions indentations at high temperatures with room temperature accuracy. This hot-hardness tester was developed under the direction of G. Warren Webb at Comstock and Wescott of Cambridge, Mass. for the Watertown Arsenal.



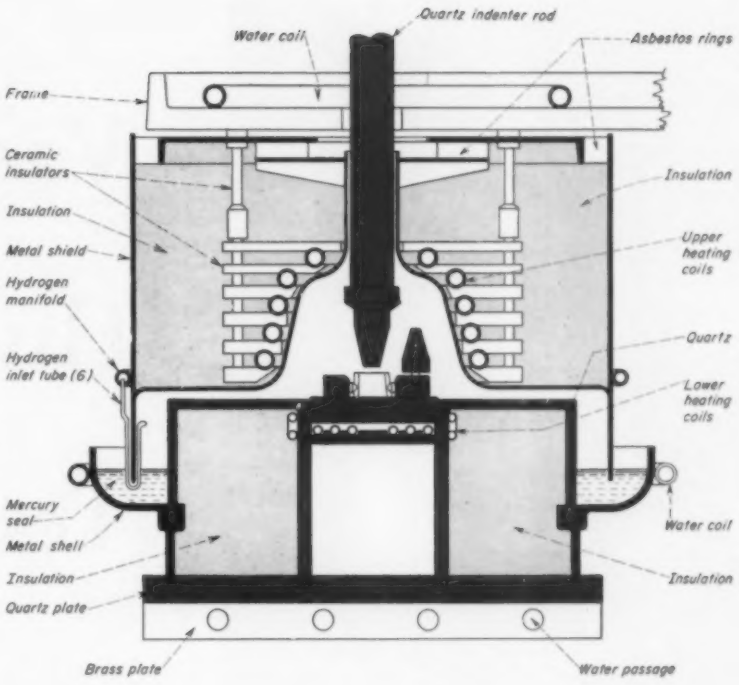
Fluid Seals Packing-Less Pump

To avoid packing maintenance and obtain higher pumping speeds, the La Bour Co., Elkhart, Ind., uses a rotating hydraulic seal in their vertical centrifugal pumps.

HYDRAULIC SEAL is integral with impeller which is only rotating part. Fluid leaks into seal chamber and is held in position by centrifugal force. Drive shaft enters suction side of pump so seal only works against atmospheric pressure under suction lift conditions and is never subjected to discharge pressure. With no close tolerance seals, operating speeds can be higher and power used to form seal is less than that consumed by friction in comparable stuffing box.



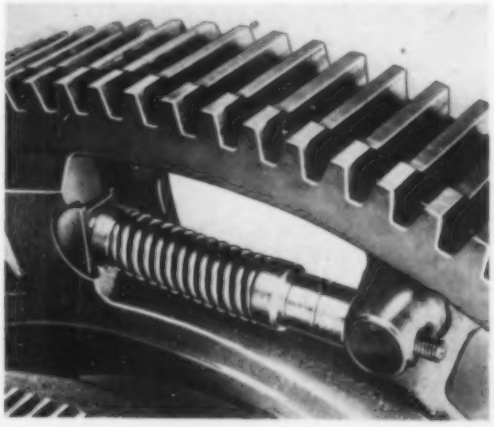
THE SAME MICROSCOPE is used to select the test area and measure the indentation. It has a mechanical stage identical to the unit supporting the lower furnace section which holds the specimen in the same relative position. Setting tester micrometers to values read at the microscope correctly positions specimen. Applying corrections for thermal expansion allows indentations to be positioned within 0.0002 in.; previous designs positioned to 0.008 in. Major design changes are in size, shape and position of operating parts in the loading mechanism to make space for furnace. The machine is constructed so a line between specimen centering pins does not coincide with the axis of stage motion; only one micrometer is moved for a series of readings. Equipment for controlling temperatures, atmosphere and purification is separately mounted.



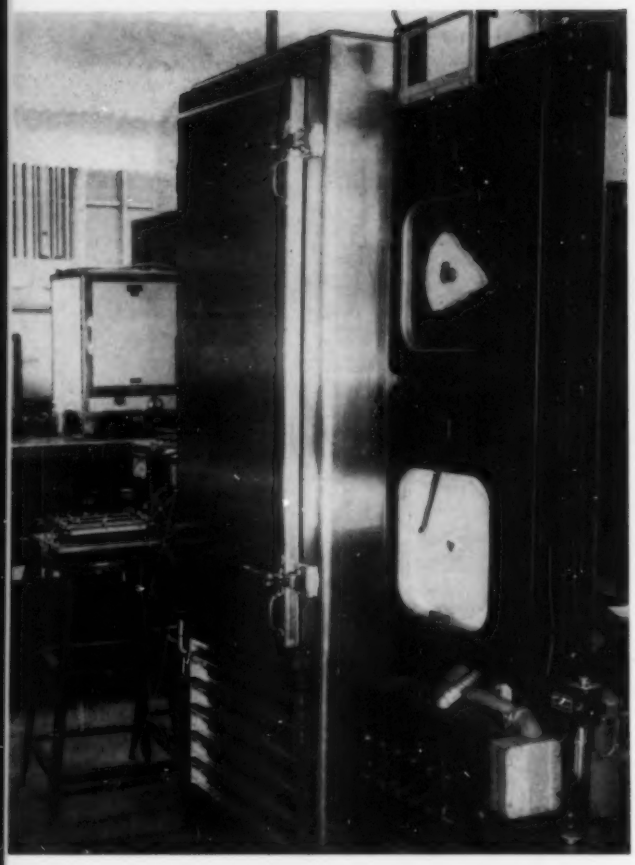
TO KEEP THE INDENTATION SMALL relative to the zone tested, the instrument uses a load range of 10 to 100 gr and a Knoop indenter. The length of the indentation is approximately seven times the width. Dry hydrogen is circulated through the furnace to prevent errors from oxidation. Quartz centering pins align the end-notched specimens on the anvil. The furnace is built in two sections. The lower section is made mainly of fused quartz to reduce thermal expansion; the upper section is made of stainless steel. Both sections are heated electrically and water cooled baffles reduce heat transfer to other parts. The lower section is raised by an elevating screw to 0.030 in. below the diamond indenter as shown by a dial indicator. A mercury filled annular trough forms a gas seal to prevent the escape of the hydrogen atmosphere.

Spring Loaded Gears Hold Register for Color Printing

Vibrations changed register of a 2-revolution book press when the cylinder was raised and lowered. Now, cylinder gear is driven by two drive gears with teeth held out-of-line by a spring to remove play and hold register. This mechanism was designed by Grafiska Maskin AB of Trollhatten, Sweden.



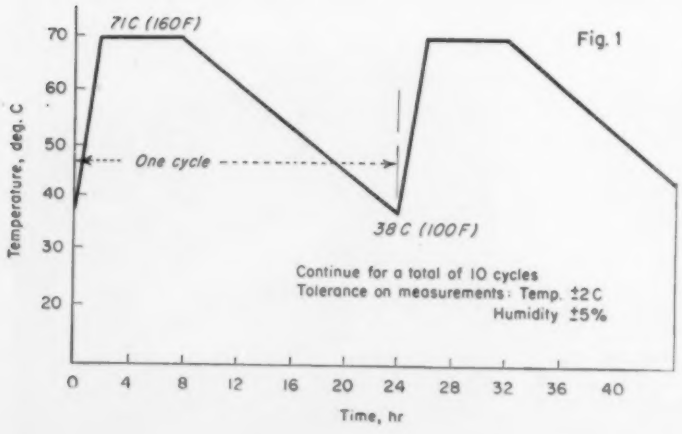
DURING FIRST REVOLUTION, type bed moves from delivery end of machine to feeder end and makes impression on paper. Cylinder then lifts to clear form during second revolution as bed returns to starting point. Backlash allowed gears to shift as cylinder changed position, which destroyed register, especially in multi-color printing. With new design, spring compression holds gears in contact at all times.



Variables in Humidity Testing

T. J. CARTIN
Environment Development Engineering, Air Arm Division
Westinghouse Electric Corporation

Current military specifications permit relatively large variations in test conditions since ratio of change of temperature and humidity are not specified. Comparison of performance of typical test chambers; procedure recommended for more consistent results.



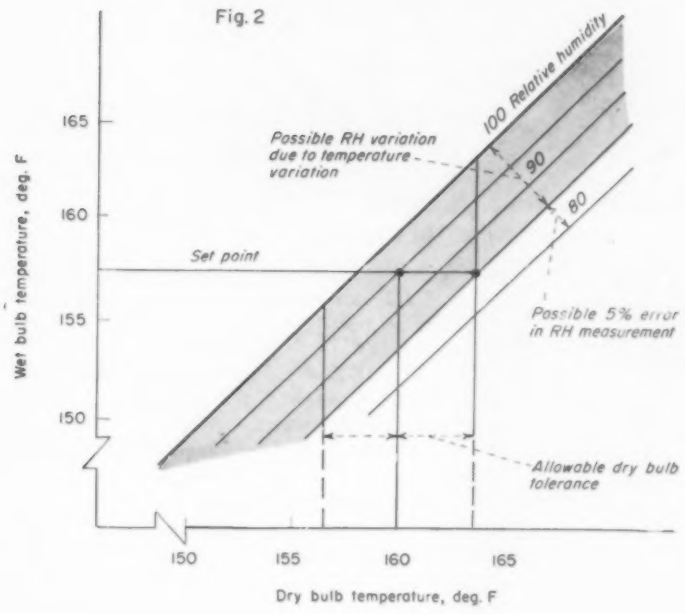
MILITARY SPECIFICATIONS MIL-E-5272A and MIL-T-5422C are the two most commonly used for environmental humidity test procedures for airborne electrical and electronic equipment. The procedure is illustrated in Fig. 1, reproduced from the specification. The accompanying instructions are "during a 2 hr period the chamber temperature shall be raised to 71 C (160 F) and the relative humidity to 95 per cent." These conditions are maintained during the following 6 hr period; during the next 16 hr, the chamber temperature is dropped at a uniform rate to 38 C (100 F).

These specifications are inadequate

Table I—Performance for Different Chambers

Chamber Volume, cu ft	Moisture Source	RH Control, 2 hr rise	RH, per cent, 6 hr steady	Cooling Period (16 hr)		Cooling Procedure
				RH Control	RH, per cent	
800	Steam injection	Yes	87.6	No	83.8	Air circulated
10	Evaporation	Not practical with evaporator	97.2	No	95.5	Air circulated
275	Immersed heaters	Not practical	96.6	No	97.7	Natural convection
570	Water Spray	Yes	90.9	No	66.7	Door cracked open
8	Water spray	Yes	99.7	Yes	98.2	Air circulation

Fig. 2



because the rates of temperature and humidity rise are not specified during the first 2 hr period, nor is a procedure specified for the 16 hr cool off period. During the 2 hr rise period the test specimen temperature lags the ambient. If the relative humidity is increasing, condensation will form on the equipment. The amount of condensation is a direct function of the rate of temperature and humidity increase and to a lesser extent the thermal inertia of the specimen.

Most of the moisture deposited will remain during the 6 hr stabilization period. At an ambient temperature of 160 F the corrosion rate is increased and the high vapor pressure promotes moisture penetration into material.

The 16 hr uniform cooling rate can be produced by three methods:

1. Shutting off all power to the chamber and allowing it to cool off. If chamber construction prevents attaining the lower limit in the specified time, then operation of the chamber blower may increase the cooling rate.

2. A programed humidity refrigeration system.

3. Opening a vent or opening the door slightly.

Specifications do not cover the relatively humidity during this period, but the most detrimental condition (and the most reproducible) is one in which the relative humidity remains at or near saturation—most easily attained by the first procedure. Under these conditions the direction of heat transfer is from the test specimen to the chamber walls, and the specimen will tend to remain at a higher temperature than the ambient and thus dry off. Alternate wetting and drying is a severe test on any material.

MEASUREMENT CONTROL

A dry-bulb temperature tolerance of ±4 F can be held by most test chambers. Relative humidity, however, is less easily and directly controlled. Use of a wet-bulb temperature is the most accurate and practical method of measurement but the tolerance is ±5 per cent. From the psychometric chart, Fig. 2, the combined tolerance in dry-bulb temperature and relative humidity measurement permits the relative humidity to vary between 100 and 80 per cent. This is true even though the wet-bulb temperature is held at the required 158 F.

SUGGESTED PROCEDURE

By raising the wet-bulb set point to 159 F a better tolerance condition is obtained. The average humidity is higher, but the variation is probably reduced somewhat. This procedure is followed in the control for the 275 cu ft chamber listed in Table I. The test is more severe, but results are more consistent. Equipment which can pass this test will pass any humidity test in existing specifications.

Designing for Fire Resistant Hydraulic Fluids

A comparison of fire-resistant fluids with quality petroleum oils on the basis of fire resistance, viscosity, oxidation, rust resistance, demulsibility, foaming, and effect on sealing materials and paints.

R. Q. SHARPE
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Socony Mobil Oil Company, Inc., New York, N. Y.

MOST DESIGNERS AND USERS of lubricating and hydraulic oils think of them as relatively safe fluids. These oils usually have a flash point of 375 F or higher with a fire point of 50 F above that, and an autogenous ignition temperature probably above 700 F. They will not ignite readily in a reservoir and will actually quench and extinguish a careless cigarette or match that has fallen into the liquid. However, in a hydraulic system under pressure, a different situation exists. In the event of a line break or leak, pressure may atomize the petroleum hydraulic oil to form an oil-air mixture that is readily flammable. In one such instance, oil atomized under a pressure of 3000 psi was ignited by a furnace forty feet away causing a flash fire that killed three men and caused severe property damage. Therefore, the designer is turning to fire-resistant fluids for many types of hydraulically actuated machines. This requires knowledge of the properties of available products and their influence on the design of equipment.

FLUIDS AVAILABLE

Although discussions of some of the fluids available have previously been presented in *Product Engineering* (see Editor's Note p 166), a review and comparison of fire-resistant products is in order. The basic types are:

1. Water-base synthetic fluids (water-glycol mixtures)
2. Straight-synthetic or non-aqueous types
   a. Phosphate ester types
      Tri-cresyl phosphate
   b. Chlorinated hydrocarbons
   c. Fluorinated hydrocarbons
3. Water-soluble oil emulsions

Each general type is available from several suppliers, and each has distinctive characteristics. All their properties differ substantially from those of a high-grade petroleum hydraulic oil (Table I).

FLUID REQUIREMENTS

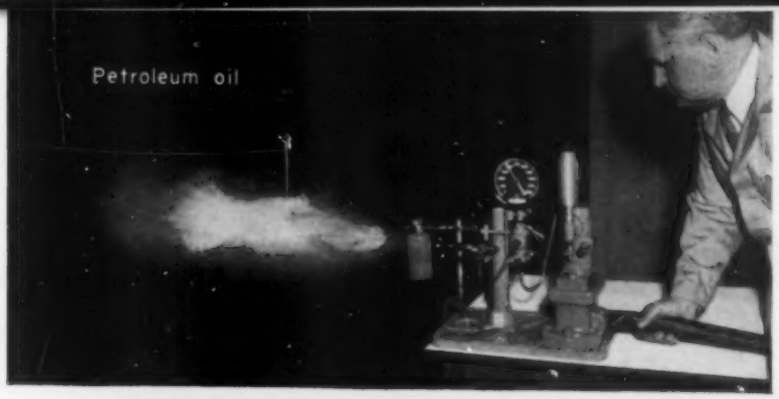
A fire-resistant hydraulic fluid suitable for industrial applications should possess the following characteristics:

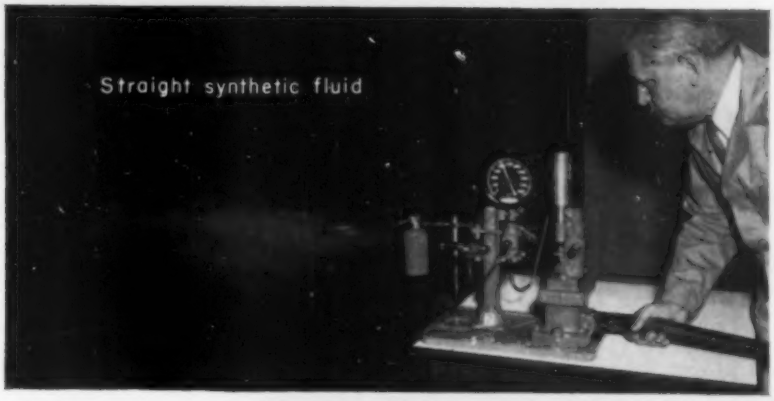
1. Good fire resistance
2. Proper viscosity
3. Good resistance to oxidation and deposit formation
4. Good resistance to wear of moving parts
5. Good resistance to rust or corrosion
6. Good demulsibility (applies only to non-aqueous fluids)
7. Good resistance to foaming.
8. Minimum effect on sealing materials.
9. Minimum effect on paints.

Table I—Typical Physical Characteristics of Hydraulic Fluids

	Petroleum Oil	Water Base Synthetic Fluid	Straight Synthetic Fluid		Water-Soluble Oil Emulsion	
			A	B		
Water Content, %	.....	35	.....	.....	45	60
Specific Gravity	0.876	1.073	1.273	1.148	0.9254	0.9478
Viscosity SUS						
100 F	225	190/210	211	219	221	499
130 F	.....	124	.....	.....	137	310
210 F	48	.....	44	43	.....	.....
Viscosity Index	100	160	.....	0 Max	161	143
Color	2½ Max	Red	Dark 1	Dark 1	White	White
Neutralization No. (max.)	0.15	Orange (ph) 9.5-10.0	0.06	0.05	.....	.....
Pour Point, F	15	−70	+5	Below 0	−10	+20
Fire Resistance	Poor	Good	Good	Good	Depends on Water Content (See note)	
ASTM Rust Test	Pass	Pass	Border	Failed		

Note. Satisfactory on malleable iron at 70 F, 90 per cent relative humidity.





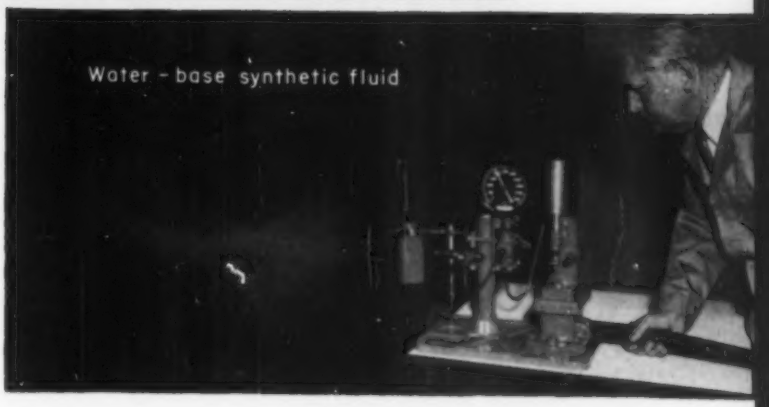


Fig 1—Fluid sprayed in finely atomized form at 3000 psi toward a propane torch to simulate hazardous conditions in a plant. Petroleum oil burns freely while fire-resistant fluids do not ignite.

Fire Resistance

Under conditions of exposure to a source of ignition, when atomized at high pressure, all three types offer substantially greater protection than a petroleum oil and are usually considered safe fluids.

Laboratory tests (Fig. 1) that closely simulate the conditions that caused the fire described above clearly establish this point. Even though residual materials in water-base fluids may burn after all the water has been evaporated, they and the straight-synthetic fluids are considered by insurance companies as acceptable fluids for hazardous locations. Water-soluble oil emulsions, while more flammable than the water-base synthetic materials, do not burn in spray flammability tests if they are 60 per cent water.

Viscosity

Fire-resistant fluids are now available in a range of viscosity that will meet most industrial hydraulic system requirements (see Table II). Water-base synthetic fluids have a high viscosity index (Fig. 2) and low freezing and pour points, which adapts them well to low temperature applications. Above 150 F, they are considered unsuitable because of the high rate of water evaporation.

Straight-synthetic non-aqueous fluids have a low viscosity index which, in some products, has been improved through the addition of viscosity index improvers (Fig. 2). Such products suffer some loss of viscosity and viscosity index in service as a result of shearing action in pump and valves. Large molecules of the high molecular weight products used as viscosity index improvers are broken up when forced through small clearances. However, some permanent improvement of the viscosity index does result from use of additives. The designer may expect that available products have viscosity characteristics suitable for average industrial equipment unless these compounds are subjected to abnormally low temperature service.

Viscosity of water-soluble oil emulsions will be influenced by the type of emulsion involved. In a conventional emulsion of the oil-in-water type, viscosity is low.

Table II—Viscosities of Commonly Available Fire-Resistant Fluids

	Saybolt Viscosities at 100 F					
	90	150	200/225	300	600	1000
Water-Base Synthetic						
Supplier A			X	X		
Supplier B		X	X	X		X
Supplier C			X			
Straight Synthetic						
Supplier D		X	X		X	
Supplier E		X	X		X	
Supplier F	X	X	X		X	X

However, in the water-in-oil type of emulsion, viscosity will increase with water content. Therefore, viscosity may be varied within certain practical limits subject to the minimum water content that will provide adequate fire resistance.

Oxidation Resistance

Substantial improvements in water-base synthetic fluids from the standpoint of oxidation stability and freedom from deposit formation have been made during the past several years. Experience has now established that if water content is maintained within recommended limits and alkalinity is checked and maintained at the recommended level the fluids will have good oxidation stability and satisfactory freedom from deposit formation. It should be noted that water base synthetics are not recommended for use at temperatures in excess of 150 F. At higher temperatures, excessive evaporation of water occurs and resulting mixture unbalance may cause some deposit formation. The system, therefore, should be designed to maintain a temperature in the preferred range. This might very well be correlated with the JIC Hydraulic Standard which has established a recommended maximum reservoir temperature of 130 F for all hydraulic systems.

Straight-synthetic or non-aqueous fire-resistant fluids have good oxidation stability and normally provide service free from deposit formation. In this respect they may be classified as approximately equal to a good grade of petroleum hydraulic oil. However, it should be remembered that oxidation stability or the ability of any hydraulic fluid to provide freedom from deposit formation is dependent on reservoir design that will prevent the entry of shop dirt or extraneous material. The tendency of any hydraulic fluid to permit deposit formation or the formation of oxidation products is greatly accelerated by contamination and by elevated temperature. Therefore, it is axiomatic that the fluids must be kept clean and operated at reasonable temperatures if trouble-free performance is to be anticipated.

Factors which apply to the water-base synthetic fire-resistant fluids would apply about equally to the water-soluble oil emulsions in hydraulic service. Prolonged operation of these liquids at high temperatures is almost certain to result in instability and deposit formation.

Wear Protection

Laboratory measurements of the relative wear protection provided by hydraulic fluids are so inconsistent and irreproducible that they cannot be considered very conclusive. In fact, the American Society for Testing Materials has not yet accepted any of the commonly used laboratory methods of evaluating this property. A product which may show up well in one laboratory test, may be at the bottom of the list in another. Therefore, it is necessary to turn to field performance in order to secure a bona fide indication of the relative wear protection offered by the available products. Experience indicates that probably more of the presently available fire-resistant fluids will equal premium quality petroleum hydraulic oil in this characteristic.

In hydraulic systems employing pumps that were designed for oil, water-base synthetic fire-resistant fluids provide generally satisfactory performance at moderate pressures. Satisfactory performance has been secured in vane, gear and axial-piston pumps employed in die casting machines, and other applications where pressures range from 500 to as high as 1800 psi. However, field performance has indicated that where heavy loads are imposed on the anti-friction bearings of pumps, increased maintenance may be required. Therefore, fire-resistant fluids for these applications should be considered only after exhaustive discussion with fluid supplier and pump manufacturer.

Straight-synthetic, or non-aqueous type of hydraulic fluids have a better record from the standpoint of wear resistance. In many applications, they have performed as satisfactorily as good-quality petroleum hydraulic fluids. There still seems to be a lack of complete information as to how they will compare, over extended service periods, with premium-quality petroleum hydraulic fluid in large pumps subjected to pressures of 2000 to 5000 psi.

Water-soluble oil emulsions now available are not as good as petroleum oils from the standpoint of wear protection. There have been many applications of water-soluble oil emulsions of the oil-in-water type to large forging and extrusion presses. This is a conventional soluble oil emulsion and is commonly applied to those systems in which it is difficult, if not impossible, to control oil leakage. In such instances, equipment is usually provided with multi-plunger-type pumps which are designed for handling water at high pressure. These pumps do not require high lubricating value in the liquid to prevent wear, therefore, water-soluble oil products provide satisfactory performance and a much greater degree of rust protection than might be secured with straight water.

Recently considerable experimental work has been done with emulsions of the oil-in-water type as well as the water-in-oil type in pumps originally designed for oil. The extent of this development work has not yet established clear-cut conclusions. General results to date indicate that the anti-wear protection provided may limit use of such products for the present to pumps operating at maximum pressures of about 500 psi. However, it

is premature to consider the general application of these products to pumps that were designed for petroleum oil until further experimental and field work has been completed.

Rust or Corrosion Protection

Rust-preventive properties of water-base synthetic fire-resistant fluids have been considerably improved during the past few years. These products, when formulated with the proper additives, will provide entirely adequate protection against rusting of metallic surfaces directly in contact with the fluid. However, an additional problem is created in service. Since they are water-base materials, some evaporation of the water will occur in reservoirs, in certain types of pumps and other parts of the hydraulic system. Highly concentrated water vapor above the fluid level may cause rusting unless it is controlled by a suitable vapor-phase corrosion inhibitor. Products are available today containing effective additives for this purpose and they provide an adequate degree of protection. Water-base fluids have an adverse effect on zinc and cadmium and these metals should be avoided in design of hydraulic systems. However, a suitable fluid in a properly designed and maintained system will provide long service without difficulty from rusting or corrosion.

Straight-synthetic, fire-resistant fluids have provided field performance that is usually free from rusting, although their rust preventive properties may not be as good as a premium-quality petroleum hydraulic fluid. In systems free from water contamination long periods of operation without the formation of rust may be anticipated. These fluids are usually non-corrosive to metals common in hydraulic systems.

Water-soluble oil emulsions of the conventional oil-in-water or less conventional water-in-oil types, when of suitable quality and emulsion strength, will provide adequate protection against rusting for most applications. These products have no corrosive effect on metals which may be commonly found in a hydraulic system and, from that standpoint, are as satisfactory as a petroleum hydraulic oil.

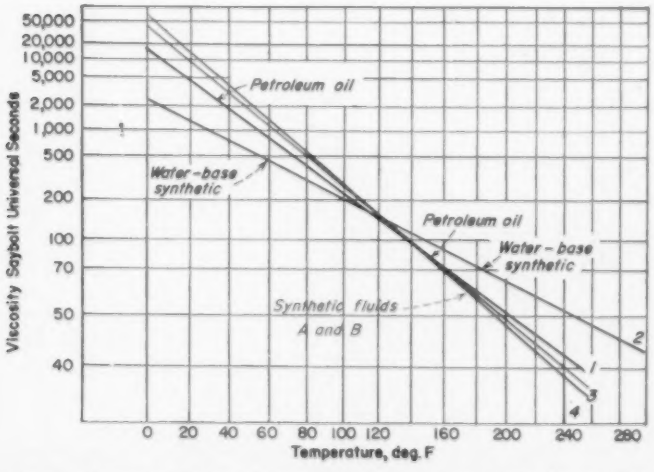


Fig. 2—Comparison of viscosities of petroleum oil and fire-resistant fluids at various temperatures.

Demulsibility

Demulsibility, the ability of the product to quickly separate from water, has no significance for either water-base synthetic fluids or water-soluble oil emulsions since both contain water. Neither of these classes should be applied where water contamination is anticipated.

Straight-synthetic, fire-resistant fluids have good demulsibility. In general, they will separate from water almost as well as a good grade of petroleum hydraulic fluid. Removal of water from a system containing such a fluid may be difficult since the fluid is heavier than water. In a centrifuge, discharge of water and synthetic fluid will be the reverse of that experienced with water and oil. Settling tanks and reservoirs must be designed to provide a means for skimming the water from the top surface of the liquid instead of draining it from the bottom of the reservoir.

Foaming Resistance

Water-base synthetic fluids will usually release air bubbles with about the same ease as a premium-quality petroleum hydraulic oil. Field performance indicates that where problems of foaming exist in service, the cause is more apt to be mechanical than the properties of the fluid. In any hydraulic fluid the tendency to foam is greatly influenced by cleanliness. In a clean system, foaming should not ordinarily occur; in a dirty system a problem may exist.

Straight-synthetic fluids do not release air bubbles as readily as equivalent viscosity petroleum hydraulic fluid. Field performance has indicated that in a suitable reservoir design, having adequate air space above the fluid level and adequate breathers, no excessive foaming occurs. Some instances of foaming can often be relieved by raising the temperature of the liquid or modifying the reservoir design to conform to well established practice. As a general rule, reservoirs that have been designed to conform to the JIC Hydraulic Standards (Fig. 3), permit use of straight-synthetic fluids without excessive foaming.

Foaming may be a problem with water-soluble oil emulsions where the emulsion strength is incorrect. However, if fluids which have established a record of satisfactory performance are used, excessive foaming is unlikely.

Effect on Sealing Materials

Sealing materials normally used in a system designed for petroleum hydraulic oil are entirely satisfactory for use with water-base synthetic fire-resistant fluid. Seals containing leather or rubber compounds of Neoprene or Buna N are relatively indifferent to suitable quality water-base fluid. Sealing materials which may require attention when installing water-base synthetic fluids, are rubbing contact seals containing cork. Water may swell the cork, increasing pressure on the rubbing part, and causing premature wear.

Straight-synthetic or non-aqueous, fire-resistant fluids have a tendency to swell Neoprene or Buna N and other similar

synthetic rubber compounds normally found in systems designed for petroleum oil. Therefore, it is necessary to incorporate seals of Butyl rubber compounds suitable for use with fluids of this type. In designing new equipment, consideration must be given to the use of Butyl rubber compounds in O-rings, radial lip-type seals, packings, flexible hoses, accumulator bladders and other such accessories. In the assembly of threaded pipe, suitable thread compound must be used. These fluids are now so widely used that most of the principal suppliers of rubber seals and packing materials have entirely suitable products available. Fluid suppliers may advise that it is unnecessary to use Butyl rubber compounds in all of the seals mentioned above; for example, in static joints.

Water-soluble oil emulsions may have a softening effect on seals designed for petroleum oil systems. Therefore, it is desirable to consult the fluid supplier and packing manufacturer regarding suitable materials. It is probable that sealing materials suitable for use with petroleum oils will be found satisfactory for water-in-oil emulsions. However, the formulation of these products may be varied as a result of further experimental work.

Effect on Paints

Water-base and straight-synthetic fire-resistant fluids will have a deteriorating effect on paints normally used for the interior reservoirs, pumps, valves, and other parts of industrial hydraulic equipment designed for petroleum oil. Therefore, if equipment is to be designed specifically for use with these fire-resistant fluids, paints should be eliminated. If interiors must be coated for protection against rust or to seal a casting, then a product suitable for the proposed fluid should be used. Interior coatings are available which are highly resistant to these fluids, and fluid suppliers should be able to provide a list of firms from whom such products may be secured.

Paints normally used in hydraulic systems designed for petroleum oil will ordinarily be suitable for use with water-soluble oil emulsions.

GENERAL DESIGN CONSIDERATIONS

In addition to design factors directly affected by fluid characteristics other things must be considered by the designer. As indicated in Table I, specific gravity of fire-resistant fluids is appreciably higher than that of a good petroleum oil. Since some forms of the equation for Reynolds Number are influenced in direct proportion to the specific gravity of the fluid, a re-examination of the flow characteristics of the fluid in relation to circuit design is important. Pipe sizes may require adjustment to keep velocities within limits that will assure laminar flow and minimum circuit vibration. This may apply to the suction side as well as the pressure side of the pump.

Purification of fire-resistant fluids may be accomplished with the same types of filters recommended for use with additive type petroleum hydraulic oils. However, moisture must be removed from the top surface of the non-aqueous fluids, not the bottom. In filtering water-base synthetic fluids there may be some advantage in using a less dense filtering unit than normally used with oil.

SUMMARY

It seems obvious that the designer of industrial hydraulic equipment is going to be working increasingly with equipment intended for use with fire-resistant fluids. In many instances, this involves changing over existing systems to accommodate the less hazardous materials, but no attempt has been made here to cover that phase of the problem. Many of the considerations outlined above apply to conversion, but many other factors must be considered such as removal of existing finishes in the reservoir, suitable purging and cleansing of the fluid being removed from the system, suitability of reservoir design and separating or purifying equipment, changeover of unsuitable seals, etc. This subject is so broad that it requires an article of its own.

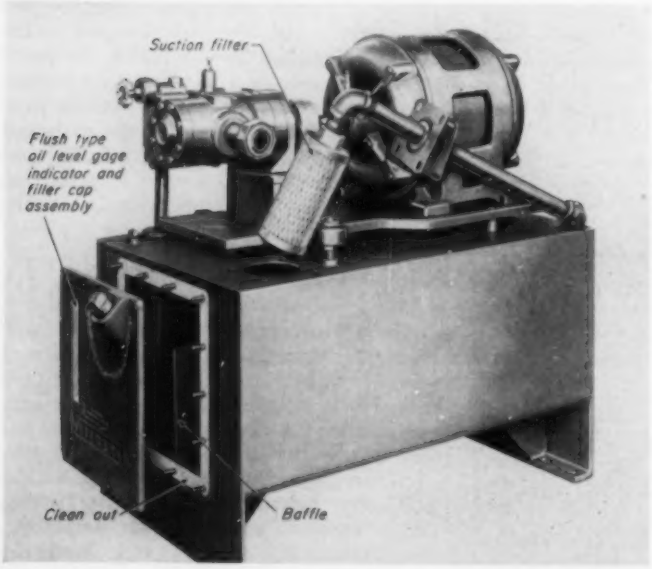


Fig. 3—This reservoir is designed to meet JIC Hydraulic Standards. In addition to ample size and ready accessibility it provides: (a)—A filler containing an air screen. (b)—Large clean-out openings. (c)—Suitable baffle. (d)—An adequate protected breather. (e)—Seals around return lines. This design contributes materially to oil and system cleanliness.

EDITOR'S NOTE:—Previous articles published in *Product Engineering* on the subject of hydraulic fluids include, "Which Characteristics for Hydraulic Fluid?" by B. B. Flick, August 1953 and "Synthetic Hydraulic Fluids," by J. S. Harris, December 1954. The former is a qualitative review of the fluids available to the designer and the characteristics of greatest importance in making the choice. The latter is a detailed discussion of the physical characteristics of the synthetic fluids and how they are determined.

The importance of proper reservoir can not be overemphasized. An interpretation and amplification of JIC standards by ten major hydraulic equipment manufacturers was published in *Product Engineering* for March 1956, under the title, "A Symposium on Oil Reservoir Design."

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Printed Wiring

FOR INDUSTRIAL SERVICE

TYPES Etched, plated, embossed, and pressed wiring.

MATERIALS Properties of copper and silver conductors; characteristics of phenolic, nylon, melamine, silicone and epoxy insulating boards.

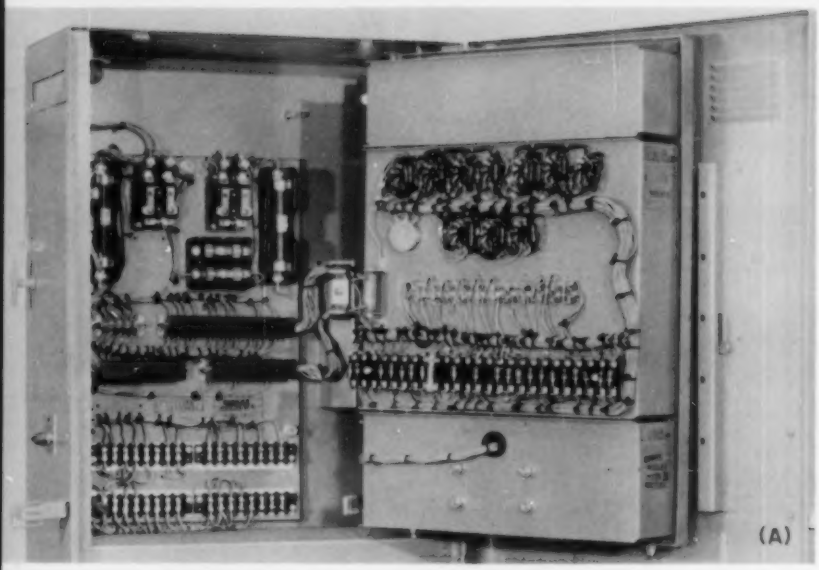
COMPONENTS Special features required of resistors, capacitors, switches, variable controls, and connectors.

DESIGN Choosing base material; determining conductor size; constructing prototype model, and preparing master drawing.

INCREASING COMPLEXITY of electrical controls for machine tools and other equipment has produced a substantial increase in number of wires used. Direct consequences are significant increases in man-hours required to prepare drawings for wiring and assembly, to cut and trim wires to length, to assemble cables and harnesses, to make terminations with screw terminals or solder, and to assemble and test the equipment. In complex equipment this can approach two-thirds the total labor cost. In addition, bulk of wiring can limit minimum size of equipment. Further, for sensitive control circuits, particularly in automatic control equipment, certain wires may be sensitive to pickup of extraneous voltages thus requiring special wiring or cabling arrangement difficult to repetitively reproduce.

Advantages of printed wiring are many. It can result in marked savings in labor costs from the initial drawing stages through assembling and final test. In addition, improved quality and reliability are obtained. Also important, printed wiring circuits can be repetitively reproduced with almost identical electrical characteristics from a few units to many thousands. When using printed wiring, reductions in both size and weight over hand-wired models is the usual experience.

Limitations of printed wiring are few. It has only moderate mechanical strength in the $\frac{1}{16}$ to $\frac{1}{8}$ in. thicknesses of copper-clad laminate usually used; this does not normally permit mounting heavy components such as transformers directly on the board. However, for special applications boards up to 2-in. thick can be obtained. Maximum current rating of foil conductors in standard thicknesses and widths is 10 to 15 amp but use of special heavy foils can increase this current rating several times. Although limited mechanical strength and slight tendency to warp can limit maximum size of wiring board, present maximum sizes are limited by the capacity of processing equipment. Maximum size of sheet supplied today is 36 by 96 in. A present major limitation of printed wiring boards is the low temperature rating of approximately 250 to 350 F for continuous operation.



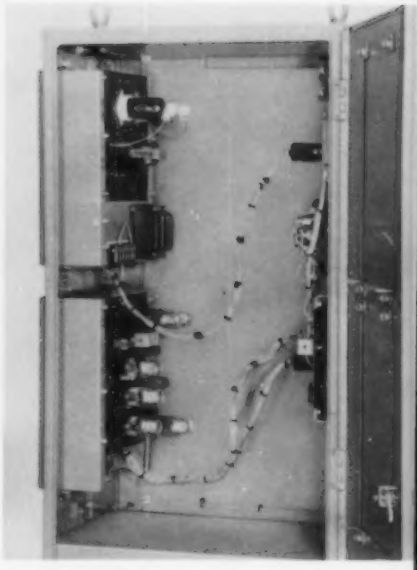


Fig. 1 — Control section of older model Westinghouse welder control (A) using conventional wiring techniques. New control section (B) using printed wiring panels shows reduction both in size and in hand wiring. As shown in (C), components of control are inserted in top of printed-wiring board through mounting holes in board. Outlines and identification numbers of components, including values, are silk-screened on board for easier assembly and servicing. Except for the small transformers,

Printed Wiring

PRINTED WIRING is an electrically conductive pattern, usually of copper foil 0.00135 or 0.0027 in. thick (1 or 2 oz per sq ft) bonded by an adhesive to $\frac{1}{16}$ to $\frac{1}{8}$ in. laminated phenolic insulating base or wiring board. The point-to-point conductor patterns are produced on one or both sides of the material. Various electrical components are inserted through holes in the board as shown at (C) in Fig. 1, a panel for a welding control. The entire assembly is then dip-soldered in one operation.

Where a complex assembly such as a switch is also required, this may be incorporated as an integral part of the wiring board, as shown by the segments in Fig. 2. Current-carrying capacity is not the usual limitation with this type wiring.

Types of Printed Wiring

More than 25 different methods have been devised to apply copper foil or other conducting patterns to an insulating base; of these, four methods in wide use today are: etching, plating, embossing, and pressing. These methods almost universally use a laminated phenolic plastic base $\frac{1}{16}$ to $\frac{1}{8}$ in. thick to which the conducting metal is applied.

Etching and embossing are destructive processes; they begin with a solid sheet of foil and remove foil in unwanted areas to leave the desired wiring pattern on the plastic base. Plating and pressing are constructive processes since copper conductors are electrolytically plated on, or silver conductors are pressed into, the phenolic. Printed wiring boards produced by standard suppliers using etching, embossing or plating cost approximately one to seven cents per square inch depending on laminate and other factors.

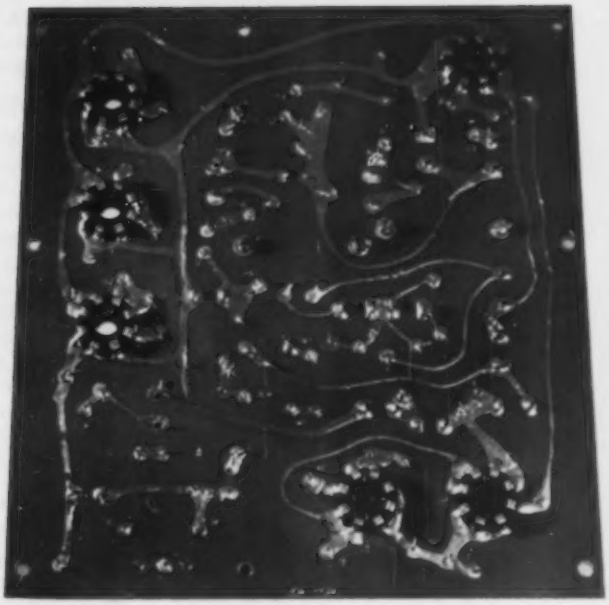
Etched Wiring

The etching process for a copper-clad laminate, (A) in Fig. 3, (see diagram on following page) starts with imprinting an etch-resistant ink or "resist" in a pattern corresponding to the desired wiring layout. The copper-clad laminate is then immersed in an etching solution which removes copper from those areas not protected by the resist. The remaining resist is then removed, leaving copper foil in the desired pattern.

Methods used to produce the etch resist on the copper surface in the desired pattern include photo-engraving, offset printing, silkscreen printing, xerography, and a dry-screen process. Photoengraving is used where a high degree of detail and accuracy in the pattern is required. This process follows steps *1* through *5* of Fig. 3 (A). Photoengraving is normally used for small to medium quantities. Offset printing, which omits step 2, is used where large quantities are required and where very fine detail is not required.

Silk-screen printing can be used for small or large production runs. Line definition is somewhat inferior to that produced by good offset printing. A No. 16XX silk screen produces a smooth edge on the etched line. Xerography or dry printing is a process which employs an electrostatic charge to form the image. It provides one of the fastest methods of producing an etch-resist pattern on a copper plate. Because of size limitations this process is good primarily for single plate production. Dry screen printing

(C)



(D)

all components are fastened to board by dip soldering. Underside of wiring board (D) shows dip-soldered conductors of wiring pattern produced by the etched process.

is a new development based on a process used to apply labels to glass. The acid resist in this case is a dry thermoplastic material applied with heat. Principal advantages are processing speed and easy removal of resist.

Plated-Etched Wiring

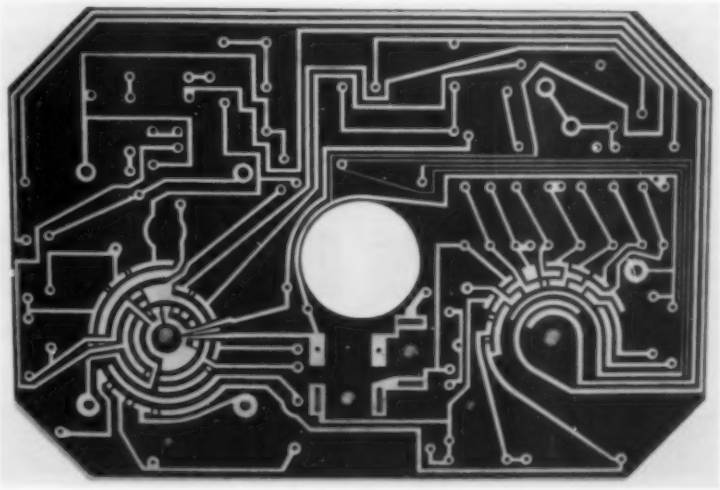
To provide good soldering properties and protect against oxidation or corrosion, printed wiring is often plated with silver or solder. A relatively hard metal coating is plated over the original copper pattern in fabricating printed switches or patterns contacted by a rubbing arm which would quickly wear through the copper.

The process used is similar to that used for etched wiring. However, the reverse of the required pattern is printed on the copper, as shown at (B) in Fig. 3, using a resist impervious to the plating bath. Exposed copper areas are then electroplated with solder, silver, nickel or rhodium as shown in step *4*. After plating, the resist is removed and the board is ready for final etching, as shown in step *5*. During the final etch the plating material acts as a resist and the circuit pattern formed by the plating remains intact.

Plated-Through Holes

Where circuits require a through connection between opposite sides of the laminated board, plating the hole is less expensive than eyelets and makes dip soldering easier. It also provides added reliability by flowing solder through the hole. As shown at (C) in Fig. 3, a reverse printed pattern, step *2*, leaves the area around the hole free of plating resist. A metal or carbon film is applied to the area in-

Fig. 2 – A complex assembly such as a switch can be designed as an integral part of the wiring pattern. This panel for a tape recorder, produced by Photocircuits, has multipole switch segments incorporated at the lower left and right-hand sections of the board.



side the hole to make it conductive. The phenolic board is then placed in an electroplating solution and the plated metal builds up from both the conductive film in the hole, and also the copper, step *3*. In the final steps the resist is removed and unwanted copper is etched away using the plating as a resist.

Plated Wiring

Plated wiring applies a conductor pattern directly on the phenolic base. This method produces through-plating of holes. The process starts with a clean phenolic board, punched with component lead and other necessary holes. An adhesive is applied, then a silver coating is sprayed on to provide the conductive coating for plating.

The board is dried and finally coated with a plating resist applied in those areas where it is not desired to plate. After plating, the resist is removed and the final step cleans the unplated areas, leaving the conductor pattern.

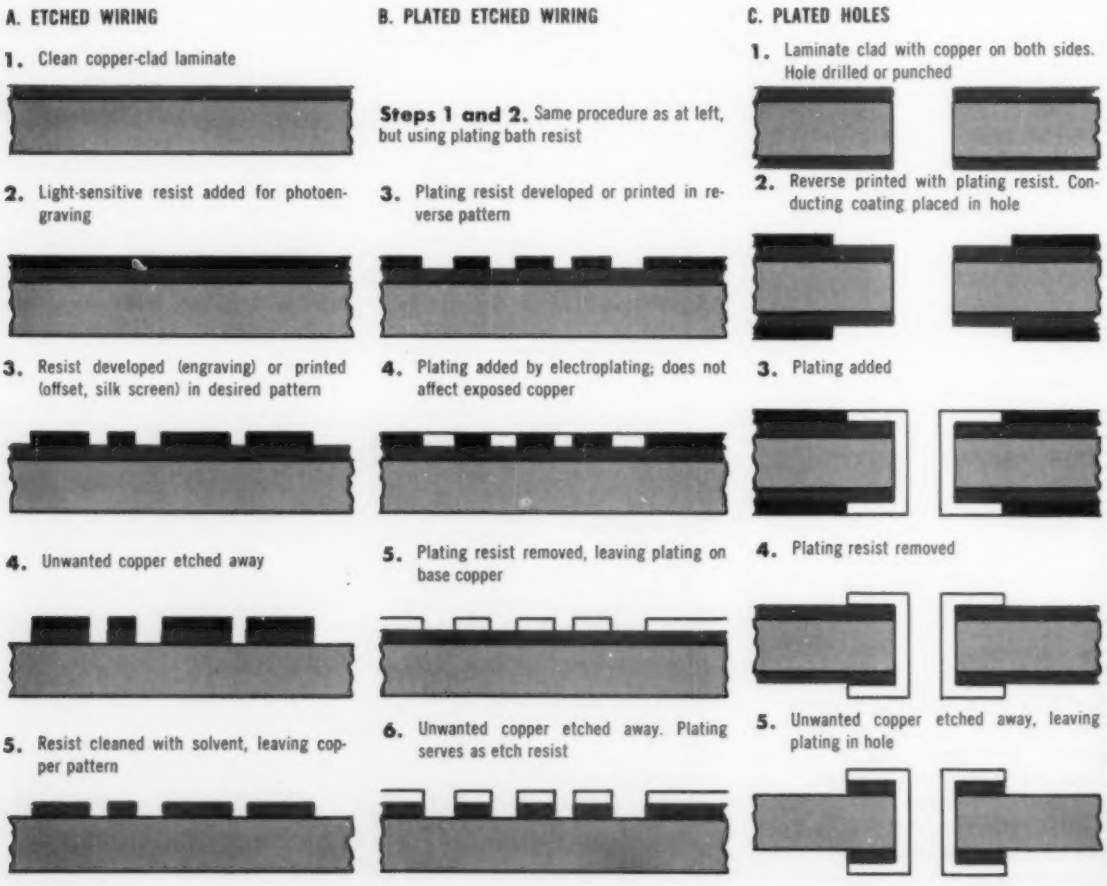
Embossed Wiring

To simplify the process of printed wiring and to eliminate electrolytes in contact with the board in etching or plating, the embossed method was developed. This begins with a standard phenolic laminate and a separate sheet of copper coated with adhesive. A die is prepared by photoetching from a master printed-wiring drawing, with the desired conductor pattern raised, as shown in Fig. 4. The die is heated and is used to press the copper foil into the laminate. The circuit pattern is pressed into the laminate, leaving unwanted portions of copper foil slightly higher. These portions are then removed by sanding and the desired conductor pattern remains embedded in the laminate. Standard copper foil thicknesses, 1 and 2 oz per sq ft, are normally used. Minimum line width and spacing with this method is $\frac{1}{32}$ in. Large conductor areas such as shields or grounds can be embossed if broken up in conventional grid patterns of alternate strips of foil and laminate.

Pressed Wiring

Pressed-silver printed wiring, like the embossed, starts with a blank phenolic laminate; but like the plated process, this method places conductors only in the areas where needed. The conductor is mechanically embossed

Fig. 3 – Steps in the process of producing etched wiring, plated-etched wiring, and plated-through holes.


A. ETCHED WIRING
1. Clean copper-clad laminate
2. Light-sensitive resist added for photoengraving
3. Resist developed (engraving) or printed (offset, silk screen) in desired pattern
4. Unwanted copper etched away
5. Resist cleaned with solvent, leaving copper pattern
B. PLATED ETCHED WIRING
Steps 1 and 2. Same procedure as at left, but using plating bath resist
3. Plating resist developed or printed in reverse pattern
4. Plating added by electroplating; does not affect exposed copper
5. Plating resist removed, leaving plating on base copper
6. Unwanted copper etched away. Plating serves as etch resist
C. PLATED HOLES
1. Laminate clad with copper on both sides. Hole drilled or punched
2. Reverse printed with plating resist. Conducting coating placed in hole
3. Plating added
4. Plating resist removed
5. Unwanted copper etched away, leaving plating in hole

on one or both sides of the board using a hot-die stamping process. This method of manufacture does not use any adhesive agent to form the bond between the conducting material and the base. Adhesion is good. This process is used principally where switches or commutators are an integral part of the wiring.

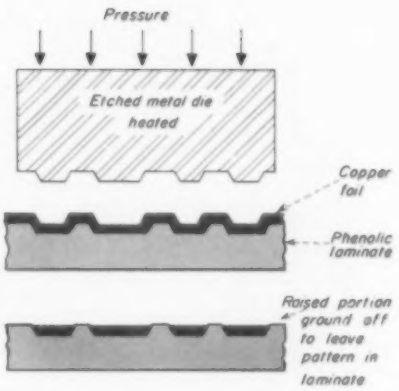


Fig. 4 – Method of producing embossed printed-circuit wiring. First, a heated etched-metal die presses adhesive-coated copper foil into the surface of a plastic phenolic laminate. Then, the raised portion of the foil is sanded off to leave lower portion of the foil, which is the conducting pattern, bonded to the plastic.

Base Materials

SEVERAL GRADES AND TYPES of laminated plastics have been combined with copper and other foils for printed wiring but most popular by far is the NEMA Grade XXXP, a phenolic resin laminate. In general, the phenolic laminates can be used if operating temperatures do not exceed 250 F, if the board is not subject to excessive shock or vibration, if slight warp of the board is acceptable, and if no arcing is present. Where conditions are more severe, other plastic materials can be used. Table I lists characteristics of various standard base materials.

Paper Base Laminates

Grade XXXP uses phenolic resin binder and is the most widely applied copper-clad material because of its excellent electrical characteristics and relatively low cost. It is recommended for applications requiring high insulation resistance and low dielectric losses under severe humidity conditions. Normally requires hot punching. Grades XXP, XP, and XX can also be used but are somewhat inferior in one or more characteristics.

Individual suppliers have made improvements in electrical and mechanical characteristics of XXXP over NEMA minimum specifications. These include better values for: moisture absorption; insulation resistance; impact, shear, and flexural strengths; cold-punching characteristics; translucency, permitting check of accuracy of top and bottom wiring pattern register; higher dip-solder temperatures and greater general heat resistance. For this reason where requirements are more demanding than NEMA standards, special types of XXXP should be considered.

Nylon Base

Grade N-1 uses a phenolic resin binder and a staple fibre nylon fabric base. It has the highest insulation re-

Table I. Grades of Plastic Laminate Used with Metal Conductor Foils

Nema Grade of Laminate	XX	XXX	XXP	XXXP	G-5	G-7	G-10	N-1
Tensile Strength, 1,000 psi								
Lengthwise	16	15	11	12.4	37	23	40	8.5
Crosswise	13	12	8.5	9.5	30	18.5	36.5	8
Flexural Strength, 1,000 psi (1/8 in. thk.)								
Lengthwise	15	13.5	14	12	44	20	55	10
Crosswise	14	11.8	12	10.5	38	18	45	9.5
Shear Strength, 1,000 psi	11	10	11	11	20	17	17.5	14
Izod Impact, ft lbs per in. of notch								
Flatwise	1.3	1.0	—	—	12.0	6.5	7.0	9.0
Edgewise	0.35	0.35	0.40	0.30	5.5	5.5	5.5	2.0
Water Absorption, 24 hrs immersion, %								
1/16 in.	2.0	1.40	1.80	1.00	2.70	0.55	0.50	0.60
1/8 in.	1.3	0.95	1.10	0.75	2.00	0.35	0.30	0.40
1/2 in.	0.55	0.45	—	—	1.50	0.20	0.15	0.35
Dielectric Strength, volts per mil, perpendicular to laminations, short-time test								
1/16 in.	700	650	700	650	350	400	500	600
1/8 in.	500	470	500	470	260	350	—	450
Insulation Resistance, megohms, 96 hrs 90% relative humidity, 95 F	60	1,000	500	20,000	100	2,500	1 million	50,000
Max Constant Operating Temperature, F	250	250	250	250	300	350	325	165

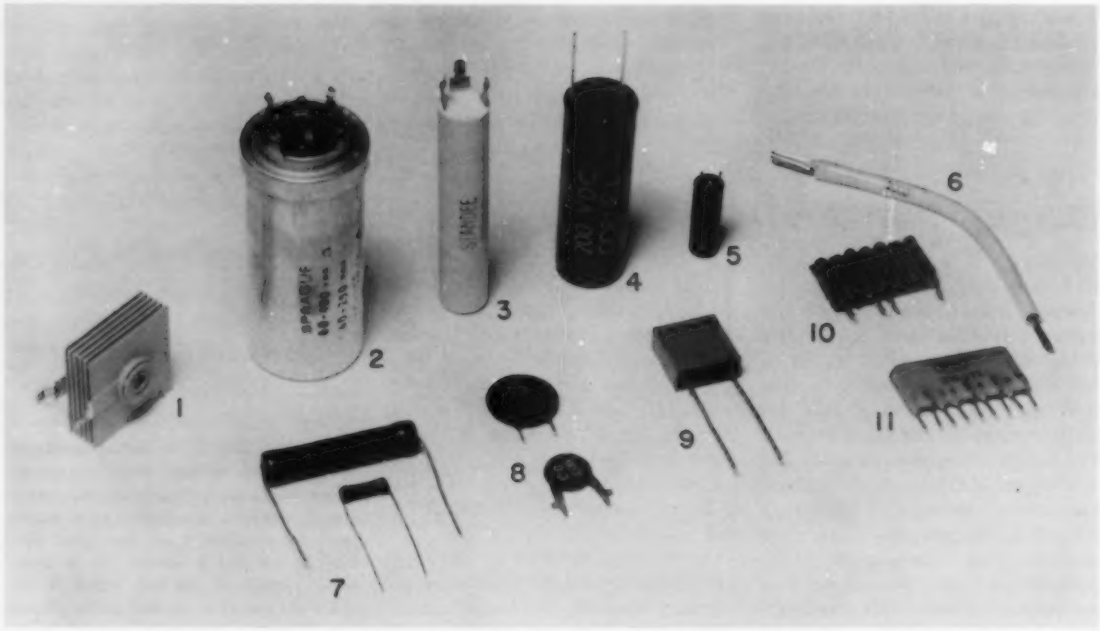


Fig. 5 – Components developed for use in printed wiring boards. These components are inserted into mounting holes in the board and then dip-soldered; consequently, the prongs or wire terminals provide both mechanical support and electrical connections. Where connection terminals alone are not strong enough to hold component securely, additional prongs or tabs are used. For components requiring connections which cannot be interchanged, such as for tube sockets, filter capacitors, or variable controls, the connecting and supporting elements are keyed to prevent improper insertion in the wiring board. 1 – Selenium rectifier by Federal with snap-in terminals. 2 – Electrolytic filter capacitor by Sprague; here, lock-in tabs are used in addition to electrical connections. 3 – Power resistor by Clarostat. Prongs are arranged to prevent improper connections; third prong is a tap to intermediate point on resistor. 4, 8, and 9 – Foil and ceramic capacitors by Cornell Dubilier. 5 – Small tubular capacitor by Aerovox. 6 – Flexible power resistor made by Lectrohm. 7 – Miniature power resistors by Dale Products. 10 and 11 – Integral units containing resistors and capacitors internally connected (made by Erie Resistor and

sistance of all grades under humid condition and combines high impact strength with excellent electrical properties.

Glass-Cloth Base

Grade G-7 uses a silicone resin binder. It has excellent electrical properties and best heat resistance of all laminates. It is, however, difficult to machine. It is recommended for high-temperature applications and where good arc-resistance is desired.

Grade G-5 uses a melamine resin, and is next to G-7 in flame, heat, and arc resistance. It has the highest mechanical strength of all grades, but is difficult to machine. It has excellent properties under dry conditions.

Grade G-10 is impregnated with an epoxy resin. It has the best surface resistivity of any copper-clad laminate. It has high mechanical strength, low dimensional change, and can be punched cold. It is recommended for circuits requiring high heat resistance and excellent electrical properties under humid conditions.

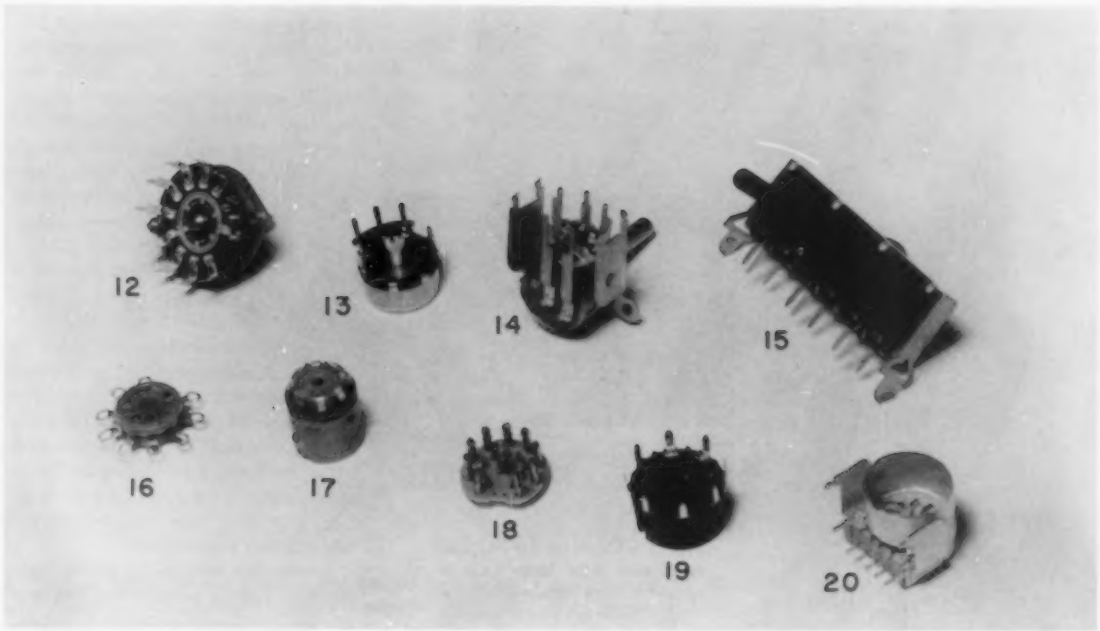
Properties of NEMA Grades of Laminates

ALL PHYSICAL AND ELECTRICAL PROPERTIES listed in Table I are of importance in printed wiring design.

Mechanical strength can be evaluated from tensile strength, shear strength, and flexural strength. Flexural strength is a term primarily associated with plastics. It is the ability of the material to withstand failure due to bending; failure of a plastic panel may arise from permanent deformation rather than from fracture. Impact resistance is stated in terms of the standard Izod test.

Water absorption is important because of changes in electrical characteristics such as dielectric strength and insulation resistance which can be caused by exposure to high humidity. Moisture absorption is also an index of the tendency of the laminate to absorb chemicals in etching or plating solutions.

Dielectric Strength is a general indication of the overall electrical quality of the material. It is an important consideration when printed wiring is used on both sides of a laminate, or when wiring on one side at a high potential is opposite metal at a ground



Onondaga Pottery) reduce number of board connections required for functional circuits. These units are mounted vertically to save space. Item 10 has prongs spaced in multiples of 0.020 in. and arranged to prevent improper insertion; item 11 has one corner removed for keying. 12 – Multipole rotary switch by Oak Mfg., with each prong serving both as connector and support. 13 – Screwdriver-operated variable resistor by Clarostat, which mounts flat against board with control shaft extending through. 14 and 15 – Variable-resistor controls by Chicago Telephone Supply; item 14 has integral switch and mounts with shaft parallel to board, while item 15 is a triple control, mounting in same fashion. 16 through 20 – Various types of tube sockets: Item 16, by Mycalex, fits into a large hole in board; tube terminals have holes for fastening socket to board with eyelets. Item 17, by Elco, snaps into single hole in board; connections are made by dip-soldering. Item 18, by Industrial Hardware, and item 19 by Sylvania, plug into circular pattern of small mounting holes which align with prongs shown. Item 20, by Aerovox, mounts tube parallel to printed-wiring board.

potential on the other side.

Insulation resistance determines spacing between conductors. For material with low resistance, conductor spacing must be greater to avoid excessive leakage current. Continued excessive leakage can eventually cause arcing and burning of the plastic base. Insulation resistance varies with both humidity and temperature; if equipment is to be used under humid or high-temperature conditions, or both, tests should be run to determine the effect on insulation resistance.

Maximum operating temperature is the maximum continuous temperature the board can safely withstand. Temperature rise and normal operating temperature of conductors should be evaluated against maximum continuous temperature. (See later section on current rating of conductors.)

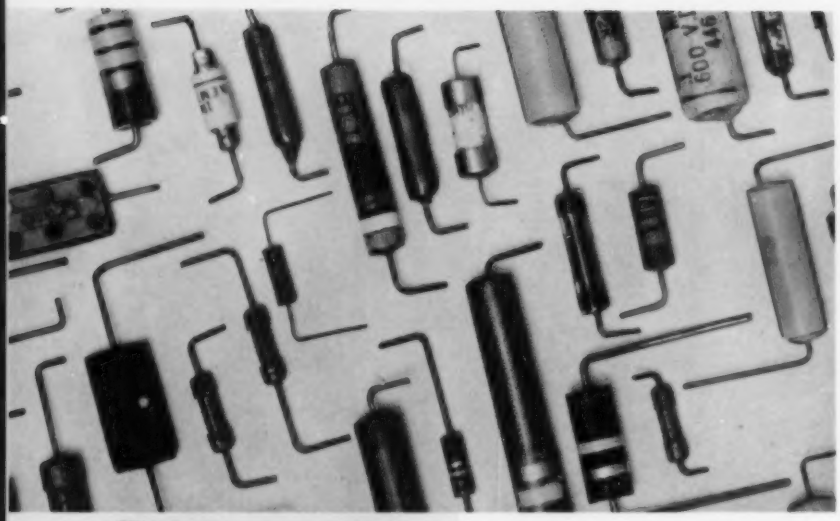
Components

TWO TYPES OF COMPONENTS are used for printed wiring: (1) those specifically designed for insertion in the board and (2) standard components which can be used without modification.

Components specifically designed for printed wiring boards are rapidly becoming available in increasing numbers and types. Several examples shown in Fig. 5 are adaptations of existing designs of such items as tube sockets, variable controls, capacitors, power resistors, rectifiers, switches, and other items formerly mounted on the metal chassis and then connected by wires to other parts of the circuit.

Terminals on printed-wiring components such as resistors and capacitors are relatively simple, since there are only two in number and interchange of the terminals during assembly does not affect circuit operation. However, tube sockets, electrolytic filter capacitors, variable controls, and switches which require connection to a specific terminal are designed with terminals arranged or keyed so that improper insertion of the component into the board is difficult or impossible. This substantially reduces errors in assembly.

Where the method of assembly varies, such as with different designs of tube sockets, terminals of the various types are designed for the specific application. For example, item 16 is fastened in place with eyelets which also form connections to the printed wiring, while item 17 is temporarily



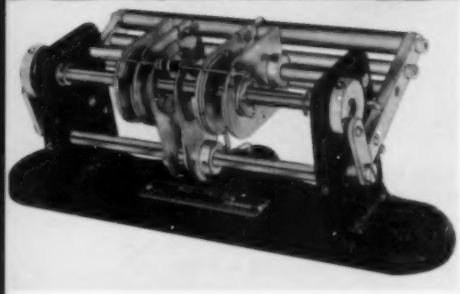


Fig. 6 — Conventional components with axial leads such as resistors, capacitors, and crystal diodes can be inserted in printed-wiring boards by bending leads in proper fashion. Components shown were prepared using this Bruno-New York foot-operated machine which can turn out over 700 per hour.

held in place by spring tension of the terminals and permanently held by dip soldering. Item 18 snaps into several round holes in the board and is held for soldering by the spring action of the round terminal tips. Item 19 is pushed into a circular row of holes corresponding to the prongs; when soldered, the bottom of the socket is flush with the wiring board.

Because all terminals are dip soldered they are precoated, plated, or tinned to aid in rapid adhesion of solder when the board is dipped into the solder bath.

Both terminal function and method of insertion of component into the board govern terminal type and configuration. For simple connections to small components such as capacitors and resistors, wire is generally used. For larger components such as power resistors or variable controls which could possibly fall out during handling between assembly and dip solder, one or more formed terminals may be on each component.

Conventional components which have axial leads strong enough to support the part can be used with printed wiring boards. Among these are carbon and wire-wound resistors; tubular paper, electrolytic and ceramic capacitors; square or rectangular mica capacitors; and crystal diodes. Typical examples are shown in Fig. 6.

Some manufacturers supply parts such as resistors with precut and preformed leads, ready for insertion into the boards. Other printed-circuit assembling departments using large quantities of components with wire leads have constructed their own machines or fixtures for bending and cutting the leads to the proper shape and size. For prototype design and moderate production quantities (up to 700 per hr) the foot-operated lead forming machine shown in Fig. 6 can be used for preparation of axial-lead components. Once adjusted the machine bends the leads and trims them to size in one operation.

Connections for a-c and d-c power and other circuits to printed-wiring boards are made by using one or more of the many special types of printed-wiring connectors currently available. Some are shown in Fig. 7. These connectors can be obtained with from 2 to 60 contacts, with contact ratings of 10 amp or more, and with insulation ratings of several hundred volts between connector terminals. These connectors are assembled with phosphor bronze, beryllium copper, or other spring-type contacts which mate with contact areas on both sides of the printed wiring board.

At the left in the illustration is a miniature connector with 12 terminals; in the center is a sectionalized type in which contacts can be added by inserting sections between the two end pieces; at the upper right is a 44-contact connector for $\frac{1}{16}$ in. board while at the lower right is a 46-contact connector used with $\frac{3}{32}$ in. laminate. These connectors can be obtained with taper tab, taper lock, wire wrap, or conventional solder connections.

Connection tabs on the printed-wiring board mate with spring contacts on the connector. Tabs are usually plated since the connector may outlast the copper foil which tends to peel back or wear through. Gold over nickel on the copper is preferred, since gold maintains minimum contact resistance for long periods of time and also solders readily. Where plating is to be used, the connector tabs can be masked against soldering in the prior dip-solder operation.

Solder plating is also widely used, although the solder surface is soft and this limits number of insertions and withdrawals of the printed wiring board before the solder is removed and copper is bared. However, the solder-plated pattern can be readily resoldered if required.

Where the number of insertions and withdrawals is high, rhodium over nickel is recommended; however, rhodium is difficult to solder. Silver plating may also be used.

Wiring board thickness must be kept within tolerances specified by the connector manufacturer. If thickness of the laminate is oversize, added plating or other build-up on the copper may produce a total thickness which exceeds the connector specifications and reduces connector life.

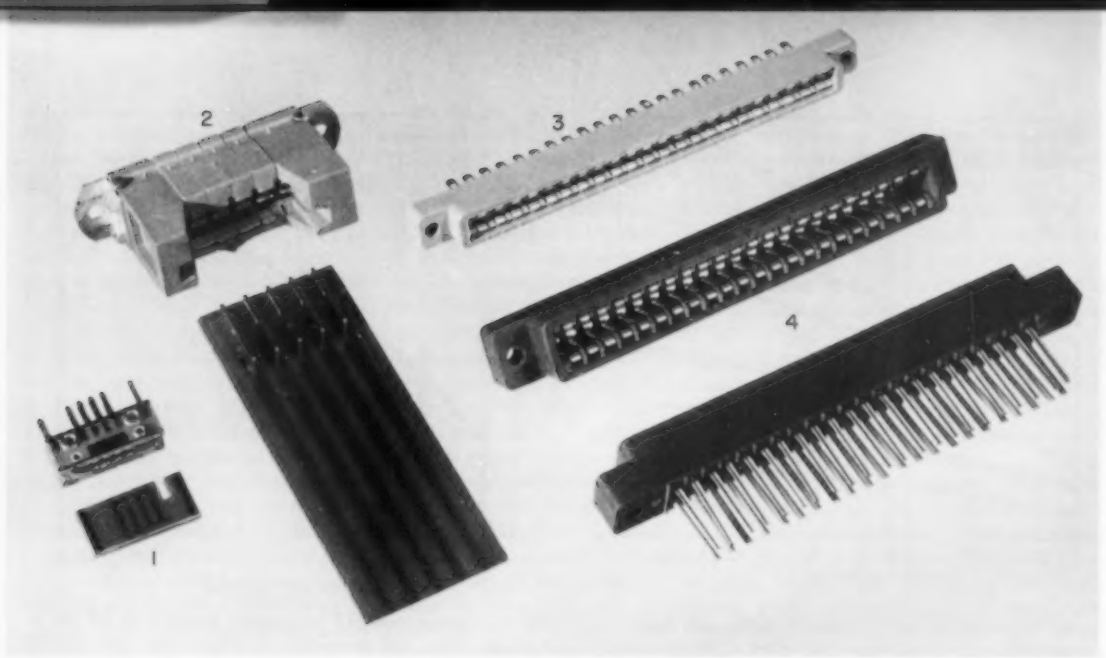


Fig. 7 – Some of the types of connectors developed for printed-wiring boards. 1 – Miniature 12-contact connector made by Circon; connector is keyed to prevent error in insertion. 2 – Heavy-duty connector by Elco has special type of male contact attached to printed-wiring board; number of contacts in this connector can be increased by inserting additional female sections between end pieces. 3 – The 44-contact connector by U. S. Components is designed for 1/16 in. wiring board. 4 – DeJur Amsco 48-contact connector for 3/32 in. board; rear view shows wire-wrap terminals.

Designing Printed Wiring

CHOICE OF THE BASE LAMINATE is the first consideration. This, however, is dependent upon the correlated evaluation of the mechanical, electrical and environmental factors involved in the particular problem.

Size and shape of the board will normally be dependent upon the number of circuit components and mounting space in the equipment. If the equipment is to be designed around the board, space-saving advantages of printed wiring can be used. If the board is to be dimensioned to a given space, then the mechanical strength of the laminate may be a major factor.

Separating the wiring into more than one printed-wiring board may be desirable for easier maintenance or servicing of the equipment. Where there are several functional groups of circuits it may be advisable to fabricate each circuit separately.

Electrical Factors such as voltage between conductors normally influences conductor spacing, while the current to be carried determines conductor width. Maximum voltage is important, since leakage resistance may determine the type of material selected. It may be advisable to examine the schematic wiring diagram and determine the maximum d-c or peak a-c voltage between any two conductors; this can become a design factor in selection of required insulation resistance.

Environment in which the board is used also plays a part in the choice of laminate. For example, if the board is used in 350 F ambient, a NEMA G-7 laminate would be the only choice since no other material has an operating temperature this high. If the unit is to operate in a highly humid atmosphere a glass-cloth base with an epoxy resin binder should be used because it has excellent electrical properties under high humidity. Barometric pressure or altitude can also affect choice of materials, since at low pressure the possibility of arc-over between high-voltage conductors is greater.

Table II – Copper Foils Used With Clad Laminates

Standard weights are 1 and 2 oz for both electrolytic and rolled copper. Rolled copper can be also obtained in intermediate thickness.

Foil Thickness, in.		Weight, oz per sq ft
Electrolytic	Rolled	
0.00068	—	½
0.00135	0.00135	1
0.0027	0.0027	2
0.0040	—	3
0.0068	—	5
0.0094	—	7

Determining Conductor Characteristics

Once the laminate is chosen, the next step is evaluation of conductor type, width, and thickness. Copper foil is available in both electrolytic and rolled types. At present electrolytic is most widely used; rolled copper provides greater surface smoothness, more uniform thickness, and reduction in the number of pits and pinholes. This results in improved etching and dip soldering characteristics. Table II lists available thicknesses of copper foil. Both 1 and 2 oz copper are almost universally used for both electrolytic and rolled copper. Both types are also available in other standard thicknesses shown; rolled copper can be obtained in any desired intermediate thickness.

Current rating generally used for design of conductors is the d-c, or a-c

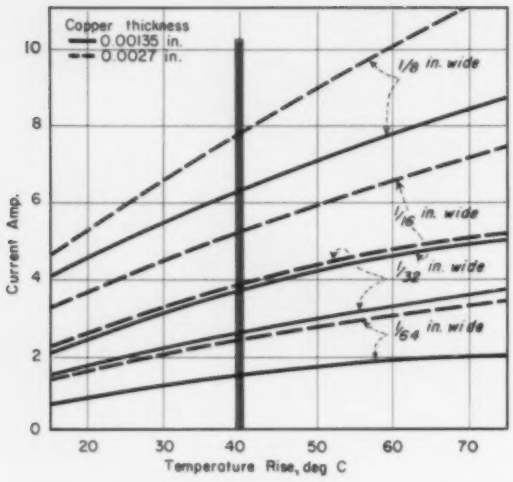


Fig. 8 – Temperature rise of standard widths and thicknesses of copper-foil conductors for various values of current. Line in color indicates standard 40 C rise design center. Ambient temperature must be added to rise to obtain true operating temperature; if this temperature approaches or exceeds the maximum continuous operating temperature, the cross section must be increased by using thicker or wider foil.

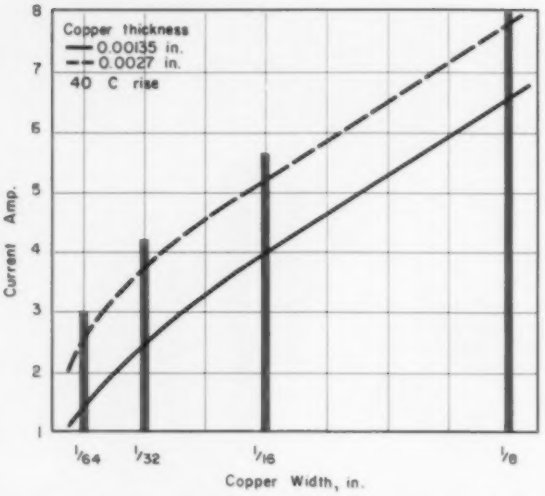


Fig. 9 – Current required to produce standard 40 C rise in standard widths and thicknesses of copper foil. This chart is useful in minimizing line width; for a given current rating intermediate values of line width can be read. Assuming 6 amp and 40 C rise, line width is slightly over 5/64 in.

Table III – Destructive Currents for Copper Foils

Foil Width, in.	Destructive Current, amp, for Foil Thickness of	
	0.00135 in.	0.0027 in.
1/32	5	8
1/16	10	15
1/8	15	20
1/4	23	35

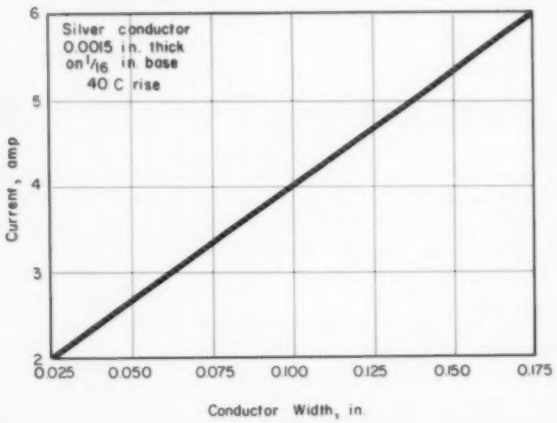


Fig. 10 – Current required to produce standard 40 C rise in various widths of 0.0015-in. thick pressed-silver conductors.

rms value, which causes a 40 C rise (104 F) above room temperature of 20 C (65 F). This means an actual foil temperature of approximately 170 F at room temperature. Conductor temperature should be watched carefully, since 170 F is near the maximum operating level for nylon base and other low-temperature materials such as polystyrene or lucite. If the equipment is to be used in ambient atmospheres much above 65 F, conductor width should be proportionately increased to lower conductor temperature and keep operating temperature within safe limits. This can be determined from Fig. 8 which shows temperature rise for various conductor widths and currents.

When using 40 C as the design center for conductor temperature rise, Fig. 9 can be used. The vertical lines at the common conductor widths of 1/64, 1/32, 1/16, and 1/8 in. intersect the amount of current which must be carried by the two most commonly used copper foil weights to produce 40 C rise.

Nominal plating thickness is 0.003 ± 0.001 in. For copper conductors formed by the electroplating process a curve drawn about mid-way between the two curves of Fig. 9 may be used.

Where conductors are subject to intermittent or periodic current surges, it is best to use maximum or peak current as the value for conductor dimension design. For purposes of miniaturization, or space saving it may be necessary to use smallest conductor width possible. Since conductor temperature rise is lower for intermittent than for continuous currents of the same magnitude, it is possible to use smaller widths without exceeding maximum allowable temperature rise. However, such cases should be carefully evaluated, and in no case should the maximum current be allowed to approach values which would destroy the foil. These values are shown in Table III for 1 and 2 oz copper of various widths.

If the board is to be designed using silver conductors, Fig. 10 can be used for determining conductor width. In this case, conductor thickness is limited to the recommended 0.0015 in.

Prototype Design

Once the required size of the board has been determined and electrical components have been obtained, mockup of the prototype model can proceed. Although the final or master drawing will be made to some enlarged scale, the prototype is produced actual size. A piece of cardboard the same shape but about one-third larger than the desired size of the wiring board should be obtained. On this, mount graph paper with 1/10-in. squares using scotch tape or rubber cement. This aids in determining final dimensions to be later transferred to the enlarged drawing and also provides a 1/10-in. coordinate system for locating mounting holes. This system is being widely adopted and machines for drilling or piercing holes based on these coordinates are available.

Position the sockets, resistors, capacitors and controls or switches to produce a satisfactory arrangement using the schematic wiring diagram as a guide. Take care to provide for heat dissipation of resistors and tubes and for adequate spacing of components having higher element voltages. Rearrangement is invariably necessary as the layout proceeds. Resistors and capacitors may be arranged at various angles to each other to provide the shortest runs and usually most compact arrangement as shown at left in Fig. 11. Or these components may be aligned parallel to each other (right) using a more complex wiring pattern. The principle advantage of this is that parts laid out in such a fashion lend themselves to automatic assembly.

Determine where input and output stages and connectors or any other terminations are to be located. Draw long unbroken a-c and d-c power and ground conductors. Lay out plate and grid connections so that the grid and plate leads of each tube are isolated from each other. A grid-type pattern can be placed between the two to act as an electrostatic shield if required.

Trace outlines of the components in place on the graph paper when the component and wiring arrangement is satisfactory. Allow at least 1/4 in. between the end of resistor or capacitor body and the bend in the wire so that bending does not damage component. When using the 1/10-in. system for hole locations, distance between centers will then be equal to the maximum length of component, plus 1/4 in., plus the additional distance to the next nearest 1/10-in. When components and terminals have been drawn in proper position, draw lines for interconnecting conductors, attempting to avoid crossover. If crossover cannot be avoided, the conductor must be rerouted.

Switches can be incorporated as an integral part of the wiring pattern when required, as shown in an earlier illustration (Fig. 2.) The switching contact areas can be applied to one or both sides of the printed wiring board. Contact arms can then be added to the board using the central hole for shaft support. Switch contact elements can be interconnected using printed wiring, thus eliminating separate wiring operations. Multiple concentric switch elements can be produced, limited only by the size of the wiring board. Printed-wiring switch boards may be stacked in the same manner as conventional wafer switches.

Flush switch-segment areas are best produced using an insulated base of melamine resin and conductor areas of nickel plating over rhodium. Life expectancy for this type is several million operations at high speeds. Rhodium plated over nickel may be used in a raised circuit switch pattern if contact bounce can be tolerated, such as in slow switching operations. Here the wiring base may be standard materials such as previouly listed in Table I. For very slow switch operations, such as by hand, pressed silver or silver-plated switch plates are widely used.

Through connections are used when necessary to provide connections between conductor patterns on both sides of a printed wiring board. These can be obtained by using eyelets in the prototype model or the more reliable plated-through holes in the production

Fig. 11 — Left, components arranged for point-to-point wiring; this generally produces most compact assembly. Right, components arranged in standardized parallel-and-right-angle pattern. This method is becoming more widely used since repair of circuit is usually easier, and also because specialized machines for punching, drilling, and assembly are available which use linear and rectangular machining dimensions based on integral multiples of 0.10 in.

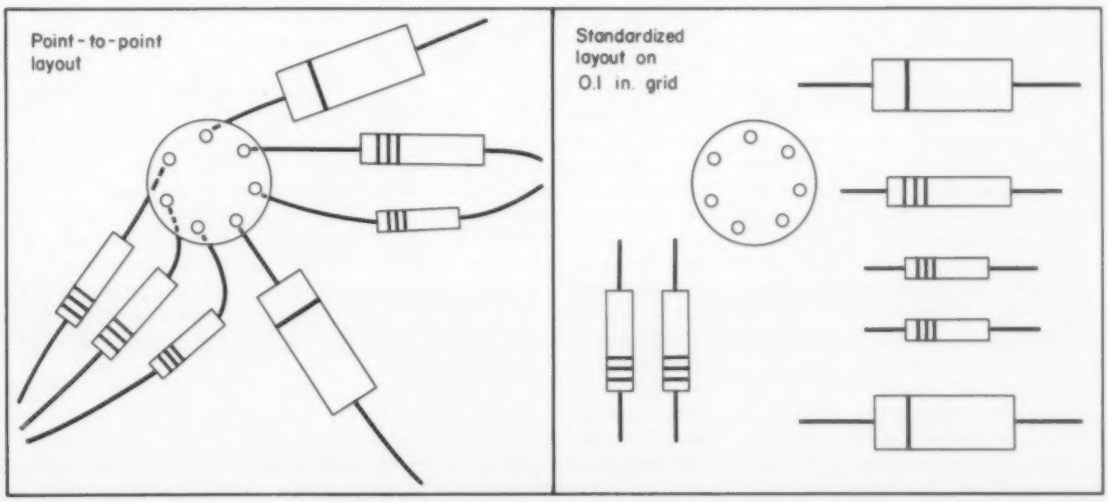


Fig. 12 — Prototype design aids. Above at left, engineering kit by Erie Resistor designed around a new system of assembly. Each strip, shown on cover, contains vertical clips into which resistors or capacitors can be snapped or readily removed. Bottoms of these clips have prongs spaced at multiples of 0.02 in. which coincide with printed wiring pattern supplied with kit. Center, kit by Micro-Circuits provides liquid silver conductor and resistor paints which can be applied with a brush; these are useful in making changes in prototype wiring patterns. At right, kit by Techniques, Inc., which includes assorted sizes of single and double-clad laminate, etching powder, tape etch resist, paint resist, and photo-sensitive resist. The tape and paint resist can be applied directly to the copper, while the photo-sensitive resist requires processing. Kit also includes hardware, tube sockets, and a printed-wiring connector. Lower left, layout of etch-resistant pattern on copper foil is simplified using tape materials or resist inks in this kit. For rapid application of resist pattern, tubes shown each have a ball-point pen which rules approximately 1/16-in. line; each tube has a different color resist for identifying patterns drawn.

model. Where no component lead is dip soldered in a plated hole, an eyelet in addition to the plating, will provide maximum reliability.

Eyelets and terminal lugs should be specified where connections may be soldered or unsoldered several times in changing components, or where vibration will be encountered and plated-through holes are not used, such as on a single-clad laminate; this hardware prevents the foil breaking away from the laminate. Eyelet diameter will depend upon dimensions of component leads; common diameters are: 1/32, 1/16, 3/32, and 1/8 in.

For the most reliable joints, gold or solder-plated eyelets should be used, since they wet readily when solder dipped. When heading over eyelets it is important to make contact with the conductor; otherwise, corrosive solder flux residues may be trapped under the eyelet heads and failures may appear later.

Once a satisfactory layout has been drawn on the graph paper, a hand-wired breadboard model can be made using an unclad sheet of the plastic laminate which is to be used as a base in the production model. Hand wiring may not be satisfactory in some cases because the electrical characteristics of conventional wiring are different than that of the foil conductor pattern. One of the prototype kits such as shown at above in Fig. 12 may be helpful at this stage. The one at the right has several sizes of single and double-clad 1/16 in. XXXP boards, together with sockets, connectors, hardware, etching power, and flexible tape and paint etch-resist.

The prototype wiring pattern is formed on the surface of the copper-clad laminate using either the tape resist, or paint resist which can be applied with ruling pen or fine brush. The resulting pattern can then be etched and the final wiring pattern drilled and components mounted.

If considerable layout work is involved requiring two or three conductor line widths, varying widths of tape resist, below left in Fig. 12, can be used. For rapid application of etch resist, the tubes shown each have a ballpoint pen which rules a 1/16 in. line; in addition each tube of resist is a different color to aid in identifying conductor patterns drawn. Where modifications in a wiring-pattern design is required after prototype test, use of conductive paints applied with a brush, center above, can save time.

To evaluate designs using embossed wiring patterns with connections based on a 0.020 in. grid system, the kit at left above provides a wiring board and component-holding strips which are

inserted vertically into the board. For rapid changes in resistor or capacitor values, resistors and capacitors of various sizes can be snapped into clips in the vertical elements without soldering.

Assembling components on the board on the side opposite the pattern is relatively simple. Resistors and tubular capacitors are handled by bending the leads over at the proper distance from the ends of the components, pushing the leads through the holes and bending them on the reverse side to prevent the component falling out; excess wire is cut off. Other components such as sockets, variable resistor controls and filter capacitors are installed by insertion in the proper keyed connection and support holes.

If single-clad boards are designed without eyelets or plated-through holes, care must be taken that the component leads do not transmit stresses to the conductor pattern and separate it from the board. Where components such as resistors or capacitors are mounted away from the board, this can be done by swaging as shown at the top in Fig. 13, or bending the leads as shown at the bottom.

Soldering the components to the board is a final step in both prototype and production wiring boards, and is normally done by dip soldering. For single-clad boards, components are mounted on the board opposite the pattern so they are not immersed in the solder during the dip. For double-clad boards with components on both sides, one side is solder dipped as for single-clad boards; after dipping the remaining components are soldered to the second side using a hand soldering iron.

Flux used is an important factor in successful dip soldering. Both plain resin-solvent, and activated resin-solvent fluxes are currently used and are applied by dipping, spraying, or brushing. The plain resin is used because residues left on the wiring board are nonconductive and noncorrosive. However, it is slow acting on tarnished metals unless all surfaces are clean; for this reason defective joints often occur. The activated flux is faster acting and can solder several metals that the plain resin could not. An indication of the general order of solderability is given in Table IV from Alpha Metals. The principal limitation of activated flux is a corrosive and conductive residue that may remain if the flux is not completely heated. For this reason, boards soldered with activated flux are cleaned with solvent following the dip soldering and preferably while the board is still warm.

Solder should be virgin metals of 60 per cent tin and 40 per cent lead melting in the range of 361 to 370 F, or eutectic 63 per cent tin and 37 per cent lead which melts at 361 F. For ceramic wafers, or other areas with silver, the solder should contain 2 or 3 per cent of silver to prevent the solder from removing the silver from the ceramic surface.

For dip soldering, flux is applied by dipping, spraying, or painting. The solder pot should be maintained between 450 to 500 F, depending upon the laminate used. After flux is applied the board is placed in the solder at a 45 to 60 deg angle, which is gradually reduced until the entire bottom of the wiring board is in contact with the solder. The board is then rocked and moved about the surface of the solder from 2 to 10 sec. XXXP laminates from several suppliers will safely withstand more than the standard 450 F for 10 sec. Before each dip the dross should be cleaned from the top of the solder to avoid unsoldered areas.

Table IV — Order of Solderability of Metals

Tin-Zinc Plate	
Gold	
Silver (Clean)	
Cadmium Plate (Clean)	
Copper (Clean)	
Tin (Hot Dipped)	DECREASING SOLDER-ABILITY
Tin Plate (Clean)	
Solder Plate	
Lead	
Cadmium Plate (Oxidized)	
Copper (Oxidized)	
Silver (Tarnished)	
Tin Plate (Oxidized)	
Nickel Plate	
Brass	
Chromium	
Aluminum	

If no dip-solder tank is available, a small hand soldering iron or gun of low wattage can be used to avoid overheating the copper foil. Special low-temperature solder alloys are available for hand soldering or touch up work when heat may damage conductors or heat-sensitive components such as diodes, transistors, or insulation.

Preparing Master Drawing

The master drawing is an enlarged drawing of the wiring board. Scale of the master depends upon required accuracy or fineness of detail required in the production model. Where board dimensions are in the order of several inches the master is generally made 2 to 4 times actual size; for smaller assemblies the scale may run from 5 to 10 to 1. A typical master drawing of a one-sided pattern, reduced to actual size, is shown in fig. 14; the accompanying table summarizes recommended dimensions (final size) for conductors of copper foil used in etched and embossed wiring, and for

Fig. 13 — Method of mounting tubular components to prevent component leads from transmitting stress to conductor pattern. Swaging or bending leads as shown minimizes chance of foil pulling away from board.

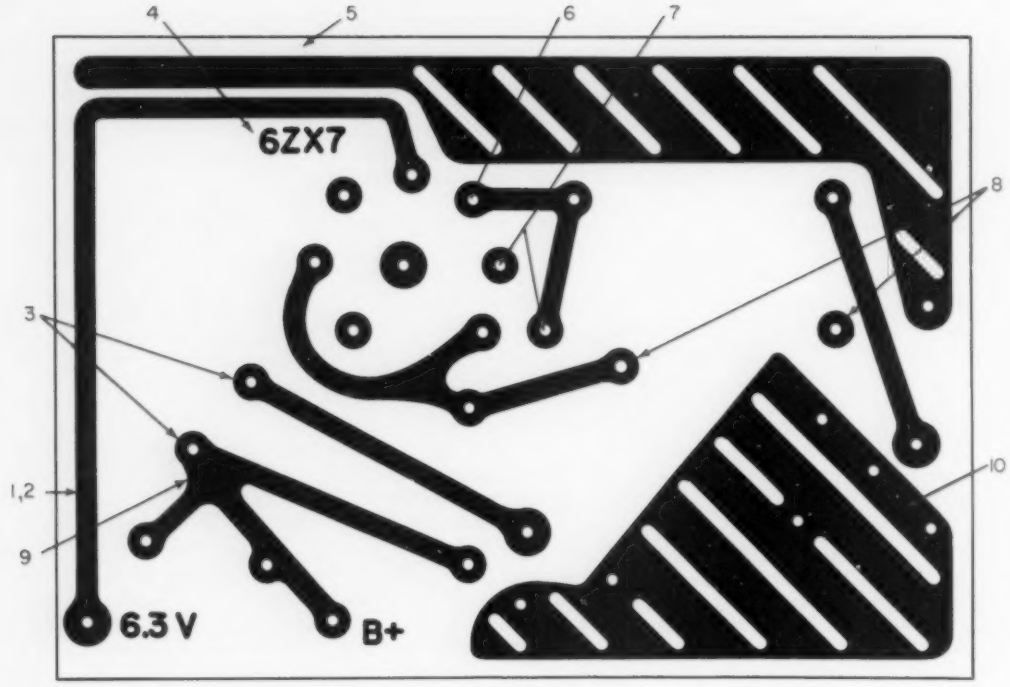


Fig. 14 – Layout of a typical master drawing reduced to actual size; chart below gives standard design data for master wiring pattern.

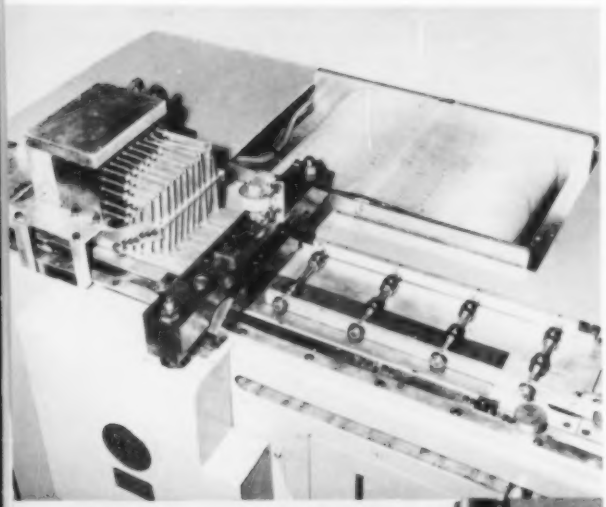
Key No.	Item	Copper Conductor Type	
		Foil	Plating
1	Conductor thickness, in.	0.00135 or 0.0027	0.003 ± 0.001
2	Conductor width, in.	1/16 to 1/8	1/16
3	Conductor spacing, in.	1/32 per 150 vdc	3/64 min
4	Letter size, min, in. Height Line width	 3/32 0.015	 1/8 0.025
5	Margin between conductor and edge of board, min, in.	1/32	Laminate thickness
6	Component insertion holes Size, min Tolerances, in. Diameter Location	 3/4 laminate thickness ± 0.003 ± 0.005	 ± 0.008 ± 0.002 per in. or ± 0.005, whichever is greater
7	Spacing between holes, min	Twice laminate thickness	Laminate thickness
8	Land around holes	At least 0.062 in. greater than hole diameter	
9	Conductor joining	Where conductors join at angle use fillets with large radius of curvature	
10	Large conductor areas	Areas greater than 1/2 in. sq should be in form of grid	

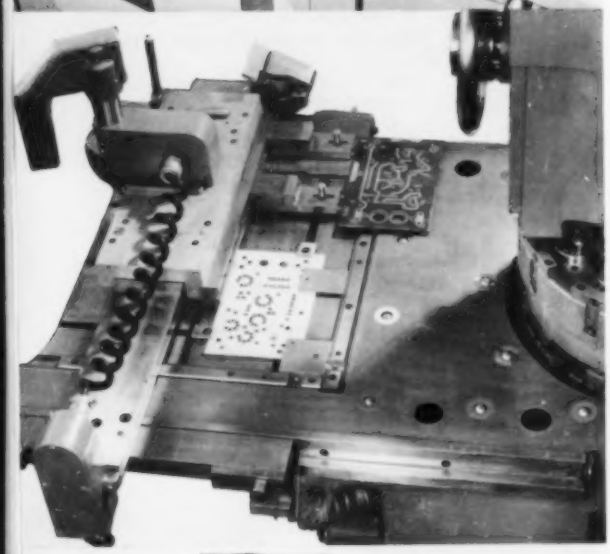
copper plating used in electroplated circuits.

Drawing cloth used should be dimensionally stable. In inking the wiring pattern, a circular "land" should be provided wherever a component lead or terminal connects to the conductor pattern. Where a termination occurs in the large conductor area of a ground or shield, the broken grid pattern normally used should be interrupted to provide a solid area around the connecting point. Examples of this may be seen at *10* in Fig. 14. Wherever a component with multiple terminals, such as a socket or switch is used, a circular land around the component insertion hole should be drawn, even though no connection is made; this provides additional mechanical support. Examples of this are shown in the insertion holes for the tube socket.

Maximum conductor widths are determined on the basis of allowable temperature rise for conductors carrying heavy currents, such as filament or heater circuits. Low-voltage conductors carrying low current, such as grid and control-circuit leads, can be 1/32 in.

All hole centers should be indicated on the pattern. Component insertion or lead termination holes should be indicated by an open circle approximately 0.20-in. final size. Hole centers not a part of the conductor pattern, such as for hardware or board mounting, should be drawn as small circles with reduced-size dimensions of 0.20-in. ID and 0.60-in. OD. When drawing the wiring pattern, conductors, lands, connector tabs and large areas broken by grids should be first outlined, then filled in with a brush or inking pen. If a two-sided pattern is being prepared, use transparent cloth for masters; accuracy of hole registration can then be





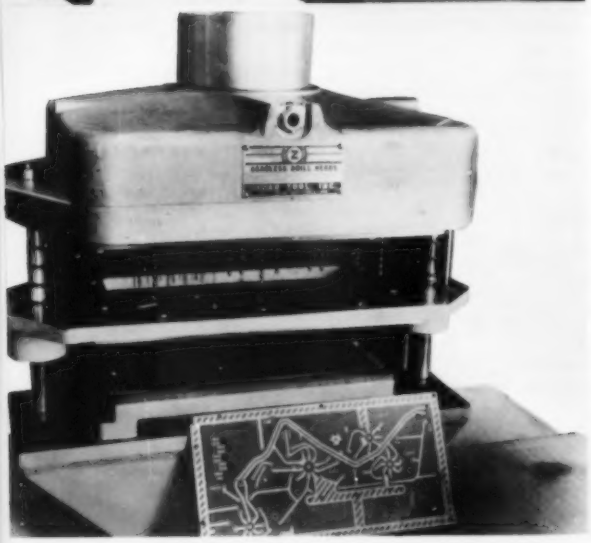


Fig. 15 – Machines for punching and drilling component insertion and connection holes in printed-wiring boards. TOP, RCA automatic hole-punching machine with covers removed. The machine is controlled by a glass-base cloth punched tape. As each hole passes over a sensing bar, one of 58 punches is operated by a solenoid. Punches are 0.052-in. dia; hole locations are based on 0.10-in. grid pattern; speed is 12,000 holes per min. Glass or paper-base laminated boards can be used, but maximum thickness is 1/16 in. CENTER, Weidemann turret punch press. To position blank board under a punch, operator uses a template shown in white in center of machine; blank board is at far side. Stock board can be used as a template. Maximum rate is about 120 holes per min, but turret carries 12 punches and several hole sizes can be punched in one work cycle. Maximum board thickness is ⅛ in. BELOW, Zagar gearless drill head showing a wiring board drilled in one operation. Board has about 150 holes, the largest 5/16-in. dia. This drill head is used in a standard drill press and can be set up with hole spacing based on any standard grid pattern. Heads with up to 375 spindles have been produced; any standard thickness of laminate can be drilled.

Table V—Minimum Recommended Bend Radius in Postformable Plastic Materials.

Where copper is located on the bend area, 0.0027 in. foil or thicker is recommended to provide sufficient strength for small radius bends. Radius is measured on inside of bend.

Location of Copper on Surface of Bend	Sheet Thickness, in.	Minimum Radius, in.
None	1/32 1/16 1/8 3/16 1/4 5/16 3/8	1/32 3/32 3/8 5/8 1 1-3/4 2-1/2
Inside	3/64 1/16 3/32 1/8	5/16 3/8 5/8 1
Outside	3/64 1/16 3/32 1/8	9/16 11/16 1-1/2 2
Both sides	1/16	1-5/8

checked by placing one master over the other. Reference and registration marks should be placed on the drawing outside the wiring pattern area.

Data required for tooling to drill, punch, blank, and otherwise machine the board should be included on a dimension drawing which accompanies the finished master drawing. Several of the base materials require heating for punching, and figures on shrinkage to be allowed should be obtained from the supplier. A typical value is 0.002 in. per in.

For holes in pilot models or for small production runs a single-spindle drill press can be used. Where any quantity is to be produced the holes can be punched using specialized equipment, Fig. 15, such as tape-programmed punching machines, top, a turret punch press, center, or the gearless drilling head, below.

Special types of laminates can be postformed into shapes other than the flat board if so desired. Single-clad or double-clad material can be used and can be formed from both sides. Table V gives the minimum recommended radius for bends in these materials.

Editor's Note:

The technique of printed wiring for industrial service is a new and rapidly expanding field. Recent industrial applications demonstrate that the process has arrived as a design tool: the motor control shown on the front cover and the welder control in Fig. 1, and in business machines, computers and instruments. While drawing considerably on earlier developments in the design of communication equipment, only recently have the specialized materials, components, processes and fabricating methods for industrial use become available.

Information and data drawn on by Associate Editor, James McDermott, in preparing this staff-written article were from a variety of sources representing a good cross section of the field at the time the manuscript was in preparation. No doubt other sources are now ready to offer their facilities. This assistance was received from five general areas:

Types of Printed Wiring

Aerovox, Special Products Div.–pressed silver; etched; integral switches, commutators
Cornell-Dubilier–etched
Croname–etched; plated
Erie Resistor–embossed
General Electric, Components Dept.–plated; Commercial Equipment–etched
Photocircuits–etched; integral switches, commutators
Technograph Printed Electronics–etched

Materials for Printed Wiring Boards

American Brass–copper foil, electrolytic
Continental Diamond Fibre–copper-clad laminates
Formica Co.–copper-clad laminates
General Electric, Laminated and Insulating Products Dept.–copper-clad laminates
Mycalex Corp.–copper-clad laminates
National Vulcanized Fibre–copper-clad laminates
Revere Copper and Brass–copper foil, rolled
Rubber and Asbestos Corp.–liquid adhesives, adhesive-coated copper foil
Spaulding Fibre–copper-clad laminates
Synthane Corp.–copper-clad laminates
Taylor Fibre–copper-clad laminates

Components

Aerovox, Pacific Coast Div.–right-angle tube sockets; Special Products Div.–electrolytic, foil, and ceramic capacitors; printed circuit resistor-capacitor assemblies
Aircraft-Marine Products–connectors
H. H. Buggie & Co.–connectors
Cannon Electric–connectors
Centralab–printed circuit resistor-capacitor assemblies
Chicago Telephone Supply–variable resistors
Cinch–tube sockets and connectors
Circon–eyelets; miniature connectors; pilot lights
Clarostat–variable resistors; resistors
Cornell-Dubilier–electrolytic, foil, and ceramic capacitors
Dale Products, Inc.–precision high-wattage resistors
DeJur-Amsco–connectors
Eby–tube sockets; connectors
Elco–tube sockets; connectors
Erie Resistor–resistor-capacitor assemblies; resistors
Federal Telephone & Radio–selenium rectifiers
General Electric, Apparatus Sales Div.–capacitors; Wiring Service Dept.–connectors
Good-All Electric–paper and mylar tubular capacitors
Harvey Hubbell, Inc.–connectors
Industrial Hardware–tube sockets
International Resistance–resistors
Lectrohm–power resistors
P. R. Mallory–electrolytic capacitors, variable resistors
Mycalex Tube Socket Corp.–tube sockets
Oak Mfg.–switches
Onondaga Pottery–printed circuit resistor-capacitor assemblies
Photocircuits–switch plates
Sprague Electric–electroyltic, foil, and ceramic capacitors; resistors
Sylvania–tube sockets
U.S. Components–connectors
Winchester Electronics–connectors

Design Aids

Dietzgen–dimensionally-stable drawing cloth
Erie Resistor–prototype design kit
Keuffel & Esser–dimensionally-stable drawing cloth
Micro-Circuits–conducting paints
Photocircuits–dimensionally-stable drawing cloth with 0.10 in. grid; templates; prototype design kit
Techniques, Inc.–Prototype design kit, etching chemicals, tube sockets, hardware, and connectors; tape and ink etch-resist kit; silk-screen kits

Manufacturing Equipment and Processing Materials

Alpha Metals–solder
W. H. Brady–tape etch resist
Bruno-New York Industries–lead forming machine
Dow Chemical–etching chemicals
Drake Electric Works–dip-soldering pots
Dry Screen Process–dry screen printer for etch-resist pattern
duPont– printing and etching chemicals
Eastman Kodak–printing and etching chemicals
Electric Soldering Iron Co.–dip-soldering pots
General Electric, Apparatus Sales Div.–small soldering irons
Haloid Co.–Xerographic printer for etch-resist pattern
Philip Hunt Co.–acid for etch using solder resist
Kester Solder Co.–solder
Mallinckrodt Chemical–printing and etching chemicals
Printed Electronics Corp.–machine for processing prototype boards
Radio Corp. of America–automatic punching machine for boards
Techniques, Inc.–tape and ink etch resist; etching chemicals
Ungar Electric–pencil-type soldering irons
Weller Electric–hand soldering guns
Wiedemann Machine–turret punch press for boards
Zagar Tool–gearless head for drilling boards

Influence of

Gyroscopic Principles

on Design

Derivation of magnitude and direction of gyroscopic couple as a function of spin speed, inertia, and precession speed. Examples of secondary effects; simple bearing loads, airplane torques and combined loads on motor bearings.

RUSSELL P. NAGORSKI
The Ramo-Wooldridge Corp.

THE GYROSCOPE has long been known by name and purpose, but the basic principles are being applied at an increasing rate. For example, the use of extremely high speed motors under certain boundary conditions requires careful consideration of gyroscopic effects if serious problems are to be avoided.

The gyroscope consists of a rapidly spinning rotor with appropriate supporting structure exhibiting the following fundamental properties:

1. **Rigidity or gyroscopic inertia.** The rotor axle, when the rotor is spinning, will maintain itself pointing in a fixed direction in space unless acted upon by external forces.

2. **Precession.** If a torque is applied to the rotor through the supporting structure, which would attempt to change the axis of the rotor, the rotor axle will precess in a plane at right angles to the planes of spin and applied torque.

Fundamentals of Gyroscopic Theory

Any quantity associated with an axis, such as angular velocity and angular acceleration, can be expressed as a vector along that axis. The sense of such a vector is usually determined by the right hand rule, where the cupped fingers indicate the sense of rotation, and the extended thumb the sense of the vector quantity. Torque, angular impulse, and angular momentum can also be expressed in this manner.

If a spinning rotor is subjected to an external torque, as shown in Fig. 1, the applied torque increases the angular momentum of the rotor by the amount ΔG colinear with the initial angular momentum G_o, and

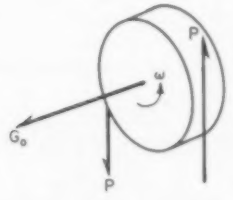


Fig. 1

therefore, can be added or subtracted arithmetically, depending on the senses of the vectors. The value of ΔG can be obtained from the fundamental equation,

$$\tau \, \Delta t = \Delta G \qquad (1)$$

The torque vector shown in Fig. 2, in contrast to the preceding illustration, lies in a plane at right angles to the initial momentum with the result that the change in angular momentum ΔG has followed the sense of the torque vector. The new angular momentum G (the resultant of vectors G_o and ΔG) will be displaced from the original angular momentum by an angle $\Delta\theta$. Since an

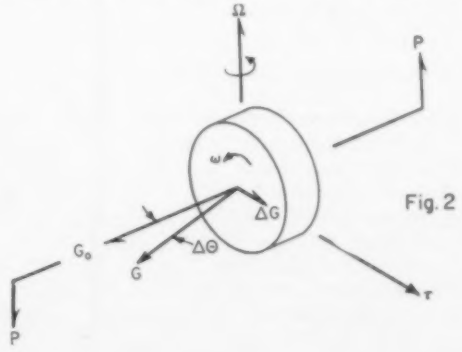


Fig. 2

angular momentum vector implies rotation in a plane perpendicular to its direction, it follows that the rotor must have turned through an angle $\Delta\theta$. Assuming that the forces on the rotor consistantly follow the motion of the shaft, the unit will rotate at a uniform velocity Ω, called the precessional velocity. If $\Delta\theta$ is very small, then the angle $\Delta\theta$ is approximately equal to its sine and

$$\Delta\theta = \frac{\Delta G}{G} = \frac{\tau\,\Delta t}{G} \tag{2}$$

and

$$\Omega = \frac{\Delta\theta}{\Delta t} = \frac{\tau}{G} \tag{3}$$

therefore

$$\tau = \frac{I}{g}\omega\Omega \tag{4}$$

This simple equation is the crux of the gyroscopic principle and explains why the gyroscope behaves as a body of a very large inertia, if a relatively high spinning velocity is present. Note that the spin (or angular momentum) vector tends to rotate so as to align itself with the applied torque vector when precession occurs. Knowing this establishes the relative senses of the vectors.

EXAMPLE 1

A motorcycle has a flywheel whose radius of gyration is 3 in. and weighs 20 lbs. The cylist rounds a curve of 30 ft radius while traveling at a speed of 30 mph and during which time the flywheel has an angular velocity of 2700 rpm. The axis of the flywheel is parallel to the axes of the wheels. What is the maximum torque on the flywheel bearings due to gyroscopic acceleration? For the flywheel

$$I = WK^2 = 180 \text{ lb-in.}^2$$
$$\omega = 90\pi \text{ rad./sec.}$$

For the motorcycle

$$v = 44 \text{ ft/sec}$$

$$\Omega = \frac{44}{30} = \frac{22}{15} \text{ rad/sec}$$

$$\tau = \frac{I}{g}\,\omega\Omega = 193.5 \text{ in.-lbs}$$

and reacts along a radial line as shown in Fig. 3.

It is evident that the cyclist must lean in so as to overcome the gyroscopic tendency of the cycle to tip. It should be noted here that this analysis, for clarity, neglects the centripetal accelerations which would increase the tendency to tip radially.

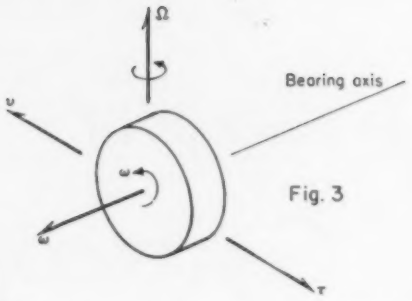


Fig. 3

EXAMPLE 2

A ship, making 35 knots, turns on course within a ½ mile circle. The propellor, shaft and output stage of the driving unit have a radius of gyration of 4.5 in., weight 10 tons, and rotate at a speed of 600 rpm. Find the couple on the shaft bearings due to gyroscopic action.

$v = 35$ knots $= 59.1$ ft/sec.
$R = 1{,}320$ ft

$$\Omega = \frac{v}{R} = 0.0449 \text{ rad/sec}$$

$I = WK^2 = 2820$ lb-ft²
$\omega = 62.8$ rad/sec.

$$\tau = \frac{I}{g}\,\omega\Omega = \frac{2820}{32.2}\,62.8\ (0.0449) = 246 \text{ ft-lb}$$

EXAMPLE 3

A compressor unit of a jet engine has a spool rated at 15,000 rpm with a moment of inertia of 50 lb-ft.² If the jet plane banks and dips into a vertical dive from a horizontal flight within a one mile radius at a speed of 500 mph, what is the magnitude of the couple experienced by the plane due to gyroscope action?

$v = 734$ ft/sec

$$\Omega = \frac{734}{5{,}280} = 0.139 \text{ rad/sec}$$

$\omega = 1570$ rad/sec

$$\tau = \frac{I}{g}\,\omega\Omega = \frac{50}{32.2}\,1570\ (0.139) = 339 \text{ ft-lbs}$$

EXAMPLE 4

A small synchronous motor is mounted on a rotating table of a tracking device as shown in Fig. 4. Calculate the loading on the motor shaft bearings due to the various

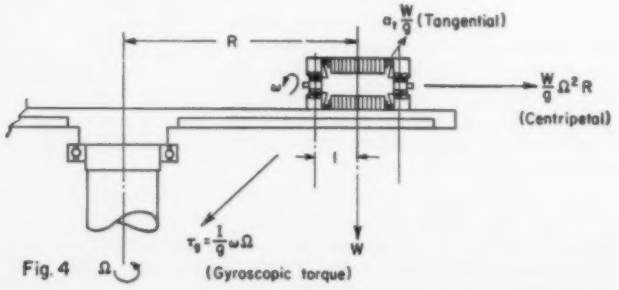


Fig. 4

SYMBOLS

g — gravity acceleration — approximately 386 in./sec.²
G — angular momentum $\left(\frac{I\omega}{g}\right)$
ΔG — change in angular momentum
I — force moment of inertia
K — radius of gyration
P — external applied force
v — linear velocity
W — weight of rotating member
α_t — tangential acceleration
Ω — precessional velocity
τ — applied torque
ω — spin velocity of rotor

inertial effects. The table drive is independent of the mounted motor and has a maximum angular acceleration of 15 rps² at $\Omega = 1$ rps. The speed of the mounted motor is constant at 200 rps.

Maximum loading is on the inner bearing with both radial and thrust components. The tangential force on the inner bearing is

$$L_t = \frac{W}{2g}\,\alpha_t$$

which is half the total tangential force.

The gyroscopic couple from Eq (4)

$$\tau = \frac{I}{g}\,\omega\Omega = \frac{WK^2}{g}\,\omega\Omega$$

and the distance between bearings is $2l$ making the vertical load on the inner bearing

$$L_v = \frac{WK^2}{2lg}\,\omega\Omega + \frac{W}{2}$$

The last term in this expression takes account of the weight of the rotor.

Calculating the resultant of these two forces which act at right angles

$$L_R = \sqrt{L_t^2 + L_v^2}$$

$$L_R = \sqrt{\left(\frac{W}{2g}\,\alpha_t\right)^2 + \left(\frac{WK^2}{2lg}\,\omega\Omega + \frac{W}{2}\right)^2}$$

Axial load on the bearing is a function of centripetal acceleration

$$L_A = \frac{W}{2g}\,\Omega^2 R$$

which assumes that this load is equally distributed between both bearings.

Relative magnitudes of these various forces can be computed to compare their relative significance. Assume that

$l = \frac{7}{8}$ in.
$W = 8$ oz.
$K = \frac{1}{2}$ in.
$R = 7\frac{1}{2}$ in.

then

$$L_t = \frac{8}{2(386)}\,(15)(2\pi) = 0.977 \text{ oz.}$$

$$L_v = \frac{8(\frac{1}{2})^2}{2(\frac{7}{8})(386)}\,(2\pi)(400\pi) + \frac{8}{2}$$
$$= 27.4 \text{ oz.}$$

and the total radial bearing load

$$L_R = \sqrt{(27.4)^2 + (0.977)^2}$$
$$= 27.4 \text{ oz.}$$

The centripetal force is only

$$L_A = \frac{8}{2(386)}\,(2\pi)^2(7\tfrac{1}{2})$$
$$= 3.07 \text{ oz.}$$

In this example, the largest force by a factor of 9:1 is caused by the gyroscopic couple.

Cracking of Welded Low-Alloy Steels

HIGH STRENGTH LOW-ALLOY MN-NI-CR-MO STEELS of type NE 9400 are prone to cracking in the heat-affected zone adjacent to fusion line of weld bead. To obtain a better understanding of the causes of crack formation in steels of this type, a joint study was undertaken by the British Ministry of Supply and the British Welding Research Association. Aims of this study were to determine mechanism of hard-zone cracking, to investigate conditions affecting formation of cracks, and to develop a method of rating the weldability of a given section with different electrodes.

Standard fillet weld cracking test was unsatisfactory because it failed to indicate the causes of crack formation. To differentiate between the effects of rate of cooling, restraint, and type of electrode on crack formation, new tests were developed.

A thermocouple was embedded in the affected part of a test plate about midway of the projected weld and temperatures during and after the welding operation were recorded on a strip-chart type of instrument. This study showed that cooling rate from 750 F was critical.

The effect of restraint, or prevention of relative motion of one plate over another during welding, was tested by welding two plates which had been previously bolted together and then welding two plates identical with those used in the first test but free to slide with respect to each other. Care was taken to maintain all other variables fixed. This test showed that restraint had practically no influence on the initiation of cracks, although cracks formed under condition of restraint were wider.

An investigation of electrodes showed that austenitic 18/8 electrodes were least likely to produce cracks, electrodes with oxidized and low-hydrogen coatings being next lowest crack producers.

Control of cooling rate is obtained by either making the fillet large enough or preheating the parts.

The significance of the critical temperature of 750 F lies in the fact that transformation of retained austenite occurs and solubility of hydrogen in steel undergoes a sudden change at this point.

The weldability index of steels in this class is found to be a function of composition and structure of the steels, of the characteristics of the electrode used and, most important, of the type of electrode cover.

Tests reported on were conducted with British Standard welding rods, but an appendix gives their composition so that a change to equivalent American welding rods is possible.

The investigation is reported by L. M. Cottrell, K. Winterton and B. J. Bradstreet, in "The Weldability of High-Tensile Structural Steels," Reprint of Ministry of Supply Report W. R. (D) 1/55, published by the British Welding Research Association, 29 Park Crescent, London, W. 1, May 1956, 79 pp and 40 figures, £1.

Table I—Allowable Temperatures and Stresses for Spring Materials

SPRING STEEL	Max. Recommended Service Temp deg F	Modulus of Elasticity 10^6 psi		Allowable Design Stresses for Compression Springs, 1000 psi			Endurance Limit Max. Stress Range for 10,000 Cycles 20,000 psi Initial Stress	
		Tension	Torsion	Light	Average	Severe	As Coiled	Shot Peened
Music wire, SAE 1085, 1090	250	30	12	100	85	70	90,000	135,000
Hard-drawn steel, SAE 1350, 1360	400	29	11.4	65	50	Not used		
Oil-tempered, SAE 1065 (MB)	400	29	11.2	80	65	55	80,000	110,000
Annealed high-carbon, SAE 1080 (HB)	400	29	11.5	82	70	57	80,000	110,000
Chromium-vanadium steel, SAE 6150	425	30	11.2	85	75	60	85,000	120,000
Silicon-manganese steel, SAE 9260	400	29	10.75	82	70	57	80,000	110,000
Silicon-chromium steel, SAE 9254	450	30	11.5	90	80	60	85,000	120,000
CORROSION RESISTANT MATERIALS								
Stainless steel, type 302, SAE 30302	550	26.5	10	70	60	50	65,000	110,000
Stainless steel, type 414, SAE 51414	450	28.5	10.5	67	57	45	60,000	90,000
Inconel	650	31	10.4	75	65	50	55,000	75,000
Monel	400	26	9.5	60	50	40	45,000	60,000
K Monel, age-hardened	450	26	9.5	65	55	40	50,000	65,000
Permanickel, age-hardened	550	30	11	65	55	40	45,000	60,000
Duranickel, age-hardened	650	30	11	70	60	45	45,000	60,000
Inconel X, spring temper + 1200 F for 4 hr	800	31	11	75	55	50		
Inconel X, spring temper + 1350 F for 16 hr	1000+	31	11	100	80	50		
Beryllium copper, ASTM B 197-52	225	17.9	7.25	60	50	40	45,000	75,000
Phosphor bronze, SAE 77, 81	225	14.5	6	50	40	30	35,000	50,000
Brass, SAE 80	175	14.5	5	40	30	Not used	20,000	

NOTE: These design stress values include the Wahl factor, and are subject to the following general adjustments:
Wire dia: under 0.020 in., increase 20 per cent; over 0.020 to 0.057 in., increase 10 per cent.
Compression springs, preset and shot peened: increase 10 to 15 per cent.
Torsion, flat, cantilever, clock and power springs: increase 50 to 75 per cent.
Extension springs: reduced 10 to 20 per cent.
Suddenly applied loads: reduced 50 per cent.

Spring Materials for High Temperature

SELECTION OF SPRING MATERIALS for high temperature or corrosive service is generally limited to stainless steels or high nickel alloys. Music wire, carbon steels and the non-ferrous alloys have a maximum service temperature of about 400 F, as shown in Tables I and II. In addition, they are not normally resistant to corrosion and other forms of high temperature attack. If, in addition, it is desirable that the spring retain maximum load capacity at the elevated temperatures, the choice of materials is further restricted and only the nickel alloys may be satisfactory.

All helical springs are subject to relaxation or creep as temperatures increase. Relaxation is the gradual loss of load under a constant deflection; creep is a slow decrease in deflection under a constant load. There is no systematic way of converting relaxation and creep data and no single equation is suitable for all materials and operating

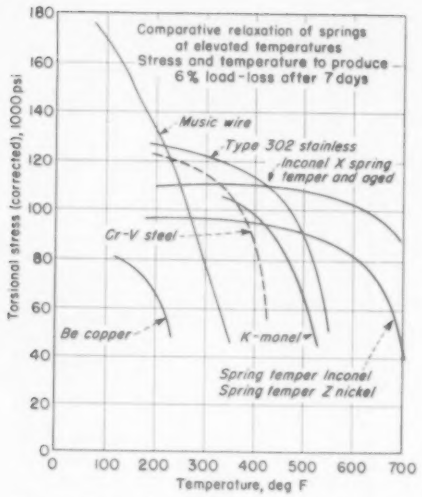


Fig. 1—Relaxation measured on springs of various materials, based on a 6 per cent load loss in 7 days. Nickel alloys are shown in color.

Data on relaxation and creep for spring materials at temperatures up to 700 F; recommended design stresses for nickel alloys for light, medium and severe duty; data on endurance properties and effect of shot peening.

International Nickel Company, Inc.

Service

conditions. Short-time tensile strength or creep-rupture strength will not predict relaxation when torsional or shear stresses are present.

Comparative relaxation data for several spring materials are given in Fig. 1 for temperatures up to 700 F. These curves are for combinations of temperature and stress that result in a 6 per cent loss in load in 7 days exposure. For all but very special applications, 6 per cent loss is generally

Table II—Comparison of Typical Spring Materials

Material	Available Size, in.	Recommended Uses
SAE 1065 Hard drawn MB Grade Carbon Steel	0.031–0.500*	Most economical of all general purpose materials. Not used where long life or accurate load-deflection characteristics are required. Not corrosion resistant.
SAE 1065 Oil Tempered MB Grade Carbon Steel	0.125–0.500*	General purpose material used where cost of music wire is not justified, and for larger sizes. Not suitable for shock loads or corrosion.
SAE 1080 Oil Tempered HB Grade Carbon Steel	0.125–0.500*	Higher tensile strength than MB grade but not always readily available. Alloy steel is often a better choice. Not corrosion resistant.
SAE 1085 Music Wire	0.005–0.125**	Most widely used material for small springs. Excellent physical properties at moderate temperatures. Not suitable at subzero temperatures or above 250 F. Also, not corrosive resistant.
SAE 6150 Chrome-vanadium steel	0.031–0.500**	Widely used where long life and fatigue strength are important and where shock loads are expected within temperature limits noted in Table I. Better physical properties than carbon steels. Also more expensive. Not corrosion resistant.
SAE 9254 Silicon-chrome	0.031–0.500	Particularly suitable for severe shock conditions. This material was originally developed for recoil springs on anti-aircraft guns.
SAE 30302 Type 302 Stainless	0.005–0.1875	Most widely used of all stainless steels. Good physical properties and corrosion resistance. Suitable for subzero temperatures. Slightly magnetic when cold worked. Cannot be hardened after cold drawing.
SAE 51414 Type 414 Stainless	0.005–0.1875	Often used instead of Type 302 but physical properties are not quite as good. Magnetic in all conditions.
SAE 51431 Type 431 Stainless		New alloy with properties approaching music wire but wider temperature range and better corrosion resistance. However, corrosion resistance is not equal to that of Type 302.
SAE 80 Spring Brass		Not often used for helical springs except where electrical conductivity is needed. Physical properties are poorest of all materials included here.
SAE 81 Phosphor-bronze		Better properties than brass but not as good as steel. Good electrical conductivity and corrosive resistance.
Beryllium Copper ASTM B197-52		Principal uses in electrical and instrument type equipment. More expensive than stainless steel.
Monel	5/8 max.	Least expensive but lowest strength of nickel group. Used mostly because of corrosion resistance or appearance. Essentially non-magnetic.
K Monel	3/4 max.	Used where better physical properties than Monel and larger sizes are needed. Costs less than stainless in small sizes. Non-magnetic.
Inconel	9/16 max.	Good combination of physical properties, corrosion and temperature resistance. Costs more than stainless but less than beryllium copper. Requires stress relief when cold coiled for minimum relaxation.
Duranickel	3/4 max.**	Often used for large springs where resistance to corrosion or temperatures up to 650 F is desired.
Inconel X	up to 3/8	Only spring material which can operate at 1000 F. Excellent corrosion resistance and relaxation properties. Allowable design stresses approach those of music wire and tool steels.

*Smaller and larger sizes are available.
**Some larger sizes obtainable.

NOTE. This table is based on data from "Selection and Application of Spring Materials," by H. C. R. Carlson, published in Mechanical Engineering, April 1956, pages 331–334.

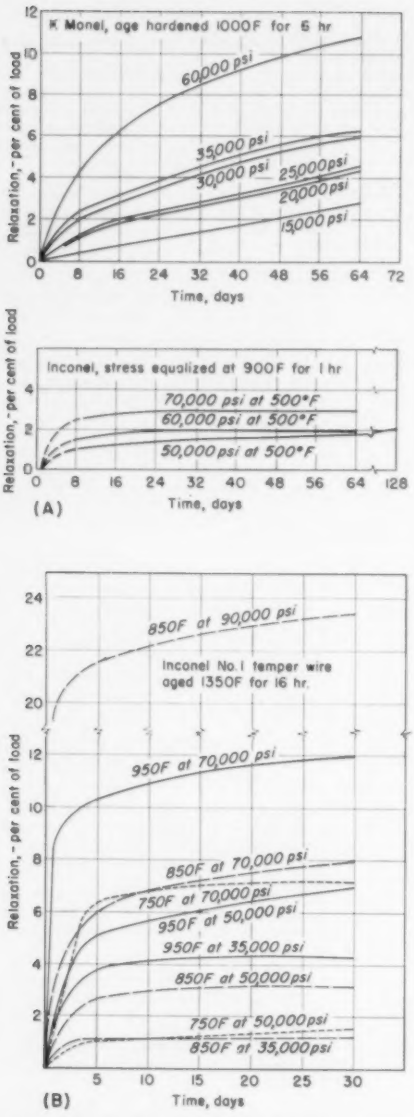


Fig. 2—Long-time relaxation of nickel alloys. (A)—K monel and Inconel springs at 500 F, reloaded to original length at 8-day intervals. (B)—Inconel springs at 750, 850 and 950 F.

considered a maximum value.

As shown by these curves, load capacity for both music wire and beryllium copper falls off rapidly with temperatures only slightly above room temperature. Chrome-vanadium steel (SAE 6150) and type 302 stainless retain their strength to somewhat higher temperatures but are not suitable for service above 450 and 550 F. Assuming 50,000 psi for allowable torsional stress, Inconel can be used at temperatures up to 650 F, and Inconel X can withstand

Table III—Design Stresses

Material	Wire Temper	Coiling Method	Thermal Treatment	Wire Dia. in
Monel	Spring	Cold	Stress-Equalized	under 0.058 0.058–0.114 0.115–0.313 0.314–0.375 0.376–0.500 0.501–0.625
K Monel	Spring	Cold	Age-Hardened	under 0.058 0.058–0.114 0.115–0.229 0.230–0.313 0.314–0.375 0.376–0.438 0.439–0.500 0.501–0.562 0.563–0.750
K Monel	Hot-finished	Hot	Age-hardened	all sizes (generally over 0.500")
Duranickel	Spring	Cold	Age-hardened	under 0.029 0.029–0.057 0.058–0.114 0.115–0.229 0.230–0.313 0.314–0.375 0.376–0.438 0.439–0.500 0.501–0.562
Duranickel	Hot-finished	Hot	Age-hardened	all sizes (generally over 0.500")
Inconel	Spring	Cold	Stress-relieved	under 0.029 0.029–0.114 0.115–0.229 0.230–0.313 0.314–0.375 0.376–0.438 0.439–0.500 0.501–0.562
Inconel "X"[b]	Spring	Cold	Age-hardened	0.312 and less
Inconel "X"[b]	No. 1	Cold	Age-hardened	0.375 and less
Inconel "X"[b]	Hot-finished	Hot	Bge-hardened	over 0.375

[a] —50% for suddenly applied loads. +25 to 35% for shot peening, wire size 0.062-in. diam. min.; +10% for cold setting.
[a]—After thermal treatment.
[b]—Higher values of ranges are those which generally depend upon cold pressing or hot setting, as applicable.
[c]—Coiled and thermally treated.
[d]—Cold-coiled, thermally treated and cold pressed.
[e]—Hot-coiled, hot-set and age-hardened.

for Springs at Room Temperatures*

Tensile Strength, 1000 psi		Proportional Limit[a]—% of tensile strength		Design Stress, 1000 psi.							
				Compression Springs				Extension Springs[b]		Torsion Springs[b]	
				Max. solid stress		Max. working stress		Max. working stress		Max. working stress	
As drawn	After Age hardening or stress relieving	Tension	Torsion	As coiled[c], uncorrected	Cold Pressed[d] uncorrected	Light service, uncorrected	Medium service, corrected	Light service, uncorrected	Medium service, corrected	Light service, uncorrected	Medium service, corrected
160	170	65–70	38–42	68	75	58–64[b]	52–58[b]	50–55	45–50	105	90
150	160	65–70	38–42	65	72	54–62	50–56	50–55	45–50	100	85
140	150	65–70	38–42	60	66	51–55	46–50	45–50	40–45	95	80
135	145	65–70	38–42	58	64	50–53	45–48	45–50	40–45	90	75
130	140	65–70	38–42	56	62	45–52	40–47	40–45	35–40	85	70
120	130	65–70	38–42	52	57	43–50	38–45	38–42	33–38	80	65
165	180	65–70	38–42	72	80	65–70[b]	60–65[b]	55–60	50–55	115	100
155	170	65–70	38–42	68	75	60–65	55–60	50–55	45–50	110	90
150	170	65–70	38–42	68	75	60–65	55–60	50–55	45–50	110	90
145	170	65–70	38–42	68	75	60–65	55–60	50–55	45–50	110	90
135	170	65–70	38–42	68	75	60–65	55–60	50–55	45–50	110	90
125	165	65–70	38–42	66	75	60–65	55–60	50–55	45–50	105	85
120	160	65–70	38–42	65	70	60–65	55–60	50–55	45–50	100	80
115	160	65–70	38–42	65	70	60–65	55–60	50–55	45–50	100	80
115	160	65–70	38–42	65	70	60–65	55–60	50–55	45–50	100	80
none required	140[h]	55–60	38–42	55–65	60–80[e]	55–70[b]	60–65[b]	45–50	40–45	65–75	55–65
170	205	65–70	38–42	80	88	70–75[b]	65–70[b]	60–65	55–60	130	115
165	200	65–70	38–42	80	88	70–75	65–70	60–65	55–60	130	115
160	195	65–70	38–42	78	85	68–73	63–68	60–65	55–60	125	110
155	190	65–70	38–42	75	82	65–70	60–65	55–60	50–55	125	110
150	190	65–70	38–42	75	82	65–70	60–65	55–60	50–55	125	110
145	190	65–70	38–42	75	82	65–70	60–65	55–60	50–55	125	110
135	185	65–70	38–42	74	81	65–70	60–65	55–60	50–55	120	105
130	180	65–70	38–42	72	79	65–70	60–65	55–60	50–55	115	100
125	170	65–70	38–42	68	75	65–70	60–65	55–60	50–55	110	95
none required	160[h]	55–60	38–42	55–65	65–80[e]	60–70[b]	55–65[b]	50–55	45–50	70–80	60–70
180	200	65–70	40–45	82	90	70–80	60–70	58–65	53–60	130	115
175	195	65–70	40–45	80	88	68–78	58–68	56–63	51–58	130	115
170	190	65–70	40–45	78	86	66–76	56–66	54–61	50–57	125	110
165	185	65–70	40–45	76	84	64–74	54–64	52–60	47–55	125	110
160	180	65–70	40–45	74	82	62–72	52–62	50–58	45–53	120	100
155	175	65–70	40–45	70	77	60–70	50–60	48–55	43–50	120	100
150	170	65–70	40–45	68	75	58–58	48–58	45–53	40–50	110	95
140	160	65–70	40–45	65	72	55–65	45–55	43–50	40–45	100	90
200–225	250–285	65–70	40–45	100–110	110–120	85–100	70–85	80–85	70–75	150	125
135–165	165–200	65–70	40–45	65–70	75–85	65–75	60–65	60–65	55–60	90	75
none required	165–185	65–70	40–45	65–70	70–75	60–65	55–60	60–65	55–60	90	75

[a]—The lower of the two modulus values is indicative of values after cold work; the higher value of the range is that which would be expected after thermal treatment.

[b]—Properties of hot-finished and age-hardened material will vary between those of hot-rolled and aged and those of annealed and solution-treated and aged, depending on the finishing temperature and amount of hot cold work imparted by coiling and subsequent hot setting.

[h]—Inconel "W" also.

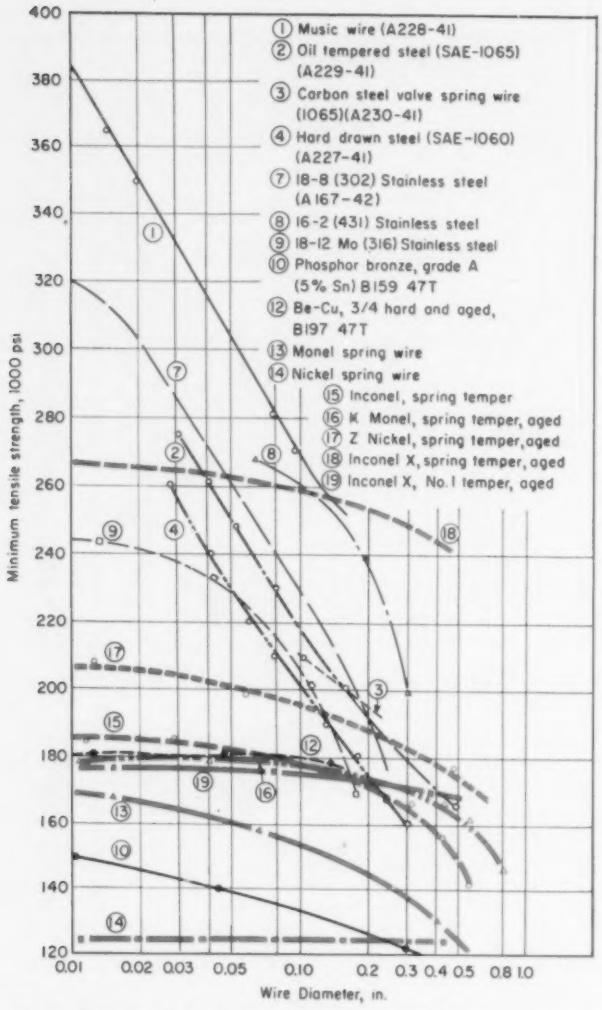

Minimum tensile strength, 1000 psi
Wire Diameter, in.
0.01 0.02 0.03 0.05 0.10 0.2 0.3 0.4 0.5 0.8 1.0
400 380 360 340 320 300 280 260 240 220 200 180 160 140 120
① Music wire (A228-41)
② Oil tempered steel (SAE-1065) (A229-41)
③ Carbon steel valve spring wire (1065)(A230-41)
④ Hard drawn steel (SAE-1060) (A227-41)
⑦ 18-8 (302) Stainless steel (A167-42)
⑧ 16-2 (431) Stainless steel
⑨ 18-12 Mo (316) Stainless steel
⑩ Phosphor bronze, grade A (5% Sn) B159 47T
⑫ Be-Cu, 3/4 hard and aged, B197 47T
⑬ Monel spring wire
⑭ Nickel spring wire
⑮ Inconel, spring temper
⑯ K Monel, spring temper, aged
⑰ Z Nickel, spring temper, aged
⑱ Inconel X, spring temper, aged
⑲ Inconel X, No. 1 temper, aged

Fig. 3—Influence of wire size on the tensile strength of typical spring materials. Heat resistant nickel alloys are shown in color.

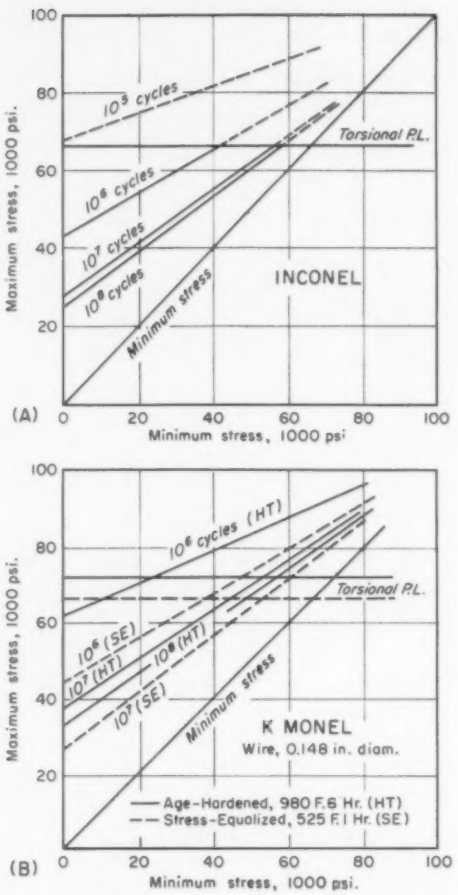


Fig. 4—Modified Goodman fatigue diagram for stress-equalized Inconel springs (above) and heat treated K Monel springs (below). For limiting stress range read vertically between line for minimum stress and maximum stress line for number of cycles. Note improvement in stress range for K Monel in the age hardened condition. All stresses are corrected for curvature.

1000 F continuously or 1100 F for short periods of time.

Performance of nickel alloys at longer periods of exposure are given in Fig. 2. These data show that K Monel has relatively low but a progressively increasing relaxation with time. Inconel and Inconel X, however, tend to stabilize with little added relaxation after about 14 days. Thus, these alloys are particularly useful for continuous operation at high temperature under high stresses.

DESIGN CONSIDERATIONS

It is not usually possible to make size-for-size substitutions between nickel base and steel alloys. Most steel springs are calculated on the basis of working stresses of 90,000 to 100,000 psi; as shown in Table I such values are too high for all the nickel alloys except Inconel X. Torsional design stresses for most of the nickel materials are in the range of 60,000 to 75,000 psi. Similarly, the ultimate tensile strength of the nickel alloys is somewhat lower than for music wire and stainless steel, as shown in Fig. 3.

Thus, when temperature or corrosive conditions dictate the use of nickel alloys, design stresses for room temperature service should not exceed the values listed in Table III. For elevated temperatures, maximum recommended stresses are given in Table IV. Only when past experience indicates that these values are too conservative should higher stresses be used. When insufficient information regarding service condition is available, a suitable safety factor must be included.

These allowable design stresses have been determined on the basis of the following:

Solid height stresses for compression springs are based on the estimated torsional proportional limit after stress relieving or age hardening.

Solid stresses after cold pressing are based upon solid height stresses plus a nominal or estimated increase to

Table IV—Design Stresses for Springs at Elevated Temperatures

All values include the Wahl Curvature Correction Factor and are based on 5 per cent relaxation maximum at stress and temperature after 7 days.

Material	Temper of Wire	Coiling Method	Thermal Treatment	Max. Stress (1000 psi.) for Temperature (°F.) Indicated												
				Up to 400	400 to 450	450 to 500	500 to 550	550 to 600	600 to 650	650 to 700	700 to 750	750 to 800	800 to 850	850 to 900	900 to 950	950 to 1000
Monel	Spring	Cold	Stress-equalized	60	40											
K Monel	Spring	Cold	Age-hardened	65	65[a,b]	50[a]										
K Monel	Hot-rolled	Hot	Age-hardened	65	65	55[c]										
Duranickel	Spring	Cold	Age-hardened	70	70	70	70[b]	60[b]								
Duranickel	Hot-rolled	Hot	Age-hardened	70	70	70	70	60[a]								
Inconel	Spring	Cold	Stress-equalized	75	75	75	75	75	60	50						
Inconel X	Spring	Cold	Age-hardened	100	100	100	90	90	85	85	80[d]	75[d]	55[d]			
Inconel X[f]	Annealed, $\frac{3}{8}$" and under	Cold	Age-hardened	70	70	70	70	70	70	70	65–70[a]	60–65[a]	55–60[a]	50–55[a]	40–50[a]	35–50[a]
Inconel X[f]	Hot-rolled, over $\frac{3}{8}$"	Hot	Age-hardened	70	70	70	70	70	70	70	65–70[a,h]	60–65[a,h]	55–60[a,h]	50 55[a,h]	40–50[a,h]	35 50[a,h]

[a]—Relatively high rate of relaxation after long time; consider Duranickel or Inconel.
[b]—Higher stresses may be obtained by cold pressing; not recommended generally for elevated temperatures because of adverse effect upon rate of relaxation.
[c]—Rate of relaxation is less than in cold-coiled springs.
[d]—For relatively short time only.
[f]—Inconel "W" also.
[g]—Use lower value for miminum rate of relaxation; and higher value where some initial relaxation and higher rate of relaxation can be tolerated.
[h]—Hot-coiled springs must be coiled at temperatures which produce mechanical properties of annealed and aged material; hot setting of springs after coiling to secure properties of hot-rolled and aged material will not introduce more work hardening than that present in cold-coiled No. 1 Temper wire and thereby would not result in higher initial relaxation or rate of relaxation.

account for cold working. Since most of the spring temper alloys do not show appreciable increases in strength beyond 50 per cent cold work, moderate increases have been established accordingly. In the case of Monel, the increase resulting from cold work is less than that for other materials because of its lower rate of work hardening.

Maximum working stresses under "light" service are based on a factor of 0.85 times the solid stress; this is approximately the maximum ratio of working stress to solid stress that is employed in good design. Since such stresses are not calculated usually to include the Wahl curvature correction factor, the stresses shown are those calculated in the conventional manner; stresses for elevated temperature service and for cyclic service include this factor. Such springs usually have less than 1000 deflections and seldom more than 10,000 in their lifetime.

"Medium" service stresses are established arbitrarily at stresses somewhat below those for "light" service and are those which might be anticipated from a Goodman S-N fatigue diagram in the area of 10,000 cycles, and which seldom reach 1,000,000 operations.

Stresses for severe cyclic service are not listed in the tables. Such springs usually are designed so that the stroke of the spring takes place from a predetermined initial deflection, with or without provision for a "stop" or "keeper" to prevent excessive deflection in service. Graphical representation of stress ranges with varying initial stresses may be presented in a modified Goodman diagram, Fig. 4, which permits selection of initial and maximum stresses, or stress ranges, for cyclic service from 100,000 to 100,000,000 cycles.

Values for extension springs are based on the minimum estimated torsional proportional limit of as-drawn wire since subsequent thermal treatments of such springs is seldom used and is impractical where initial stress is desired.

Values for torsion springs are estimated from the proportional limit in tension.

In addition to these considerations, it may be necessary to use design stresses lower than the values listed in Tables III and IV because of changes in modulus of elasticity with temperature. For accurate calculations, the data in Fig. 5 can be used to make necessary allowances. However, for most applications this can be neglected.

Other factors which may reduce the allowable stresses are corrosive conditions, impact or shock loads, or production techniques and thermal treatments that do not correspond to the ones used in obtaining these data. For example, Table V shows how mechanical properties of nickel alloys vary with different heat treating methods after cold coiling. For best properties, the thermal treat-

Table V—Properties and Fatigue Strengths of Nickel Alloy Helical Springs

Wire dia., 0.148-in.

Alloy	Thermal Treatment After Cold Coiling	Properties of Wires			Fatigue Strength or Stress Range of Springs, 1000 psi. (Curvature Correction Factor Included) Initial Stress—10,000 psi. No. of Cycles		
		Tensile Strength, psi.	Torsional Breaking Strength, psi.	Torsional Proportional Limit, psi.	10^6	10^7	10^8
Monel	As drawn	156,800	110,300	67,900	.....	.....	.....
Spring-temper wire,	Stress-equalized, 525F, 3 hr	175,000	110,100	61,100	45,000	35,500	34,500
75 per cent reduction	575F, 1 hr	167,000	104,900	64,700	.....	.....	.....
K Monel	As drawn	162,500	106,300	67,500	.....	.....	.....
Spring-temper wire,	Stress-equalized 525F, 3 hr	171,800	107,200	67,500	.....	.....	.....
65 per cent reduction	Aged 980F, 6 hr., plus 900F, 6 hr	197,000	137,200	74,600	55,000	44,000	39,500
Duranickel	As drawn	174,800	126,700	70,200	.....	.....	.....
Spring-temper wire,	Aged 980F, 6 hr., air cooled	225,000	139,700	76,200	33,500	35,000	41,500
65 per cent reduction							
Inconel	As drawn	172,000	115,000	74,000	.....	.....	.....
Spring-temper wire,	Stress-equalized 400F, 1 hr	181,000	119,000	73,900	.....	.....	27,500
65 per cent reduction	Stress-equalized 600F, 1 hr	191,000	121,500	73,000	45,000	33,000	30,000
	Stress-equalized 800F, 1 hr	194,000	121,900	71,400	.....	.....	31,000
	Stress-equalized 900F, 1 hr	193,000	123,900	66,000	50,000	35,000	32,000
	Stress-equalized 1000F, 1 hr	190,000	119,100	61,100	.....	.....	30,000
					Initial Stress—20,000 psi.		
Monel	Stress-equalized 525F, 3 hr	175,000	110,100	61,100	59,000	49,000	46,000
K Monel	Aged 980F, 6 hr., plus 900F, 6 hr.	197,000	137,200	74,600	59,500	51,000	47,000
Duranickel	Aged 980F, 6 hr., air cooled	225,000	139,700	76,200	55,000	45,000	44,000
Inconel	Stress-equalized 600F, 1 hr	191,000	121,500	73,000	55,000	40,500	40,000
Inconel	Stress-equalized 900F, 1 hr	193,000	123,900	66,000	60,000	42,500	42,000

Table VI—Recommended Thermal Treatments for Nickel Alloy Springs

(Furnace cooling preferred)

Alloy	Condition	Stress Equalizing*		Age-Hardening	
		Temp. °F.	Time Hr.[a]	Temp. °F.	Time Hr.[a]
Monel	Cold-coiled	575	½[b] to 1	Not possible	
K Monel	Cold-coiled	575	½[b] to 1	1000	4–10[f]
K Monel	Hot-coiled	Not recommended		1100	8–16[f]
Duranickel	Cold-coiled	575	½[b] to 1	1000	4–10[f]
Duranickel	Hot-coiled	Not recommended		1100	8–16[f]
Inconel	Cold-coiled	800[c]–900[d]	1	Not possible	
Inconel X	Cold-coiled[g]	875	3	1200[g]	2–4[f]
Inconel X	Cold-coiled[e]	Not recommended		1350[e]	16
Inconel X	Hot-coiled	Not recommended		1350	16

* Not necessary when alloy is age hardened.

[a]—for air-circulating ovens; for liquid baths, the time may be reduced 30 to 50 percent.

[b]—for small sizes only.

[c]—for general service (700° to 750°F. is satisfactory for light service).

[d]—for minimum relaxation at elevated temperatures.

[e]—No. 1 temper only; recommended for maximum resistance to relaxation at elevated temperatures.

[f]—Shorter time is satisfactory usually (See Fig. 2). longer heating time plus cooling at 25°/hr. down to 900°F., or equivalent step-down furnace cooling, recommended only for maximum properties obtainable.

[g]—spring temper only to obtain maximum hardness and strength; not recommended where maximum resistance to relaxation at elevated temperatures is desired.

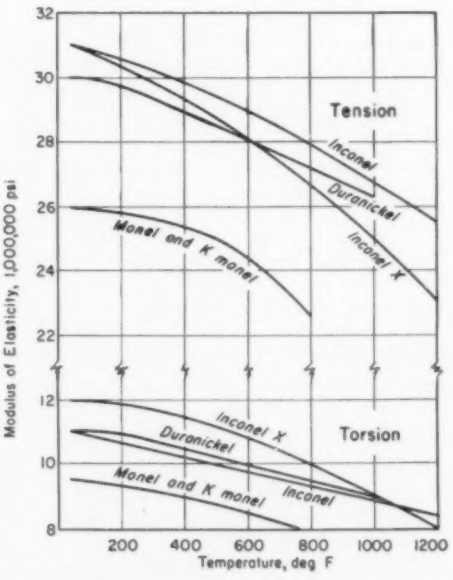


Fig. 5—Effect of temperature on modulus of elasticity of nickel alloy spring wire.

ments listed in Table VI are recommended. Furnace cooling should be used at all times for uniform results.

The proper choice of thermal treatment for Inconel X will depend upon the design requirements. In the spring temper and aged condition, Inconel X offers maximum strength but will begin to show effects of relaxation at temperatures above 650 F. Thus, this temper and treatment should be used only when stresses of about 100,000 psi are needed, where space is limited, or where periods of exposure to temperature are a matter of hours rather than days or weeks at a time.

For all other conditions, where minimum relaxation is of prime importance or service temperatures exceed 800 F, No. 1 temper wire (130,000 to 160,000 psi tensile strength) is preferred. Normally, this thermal treatment consists of aging at 1350 F for 16 hr after cold coiling.

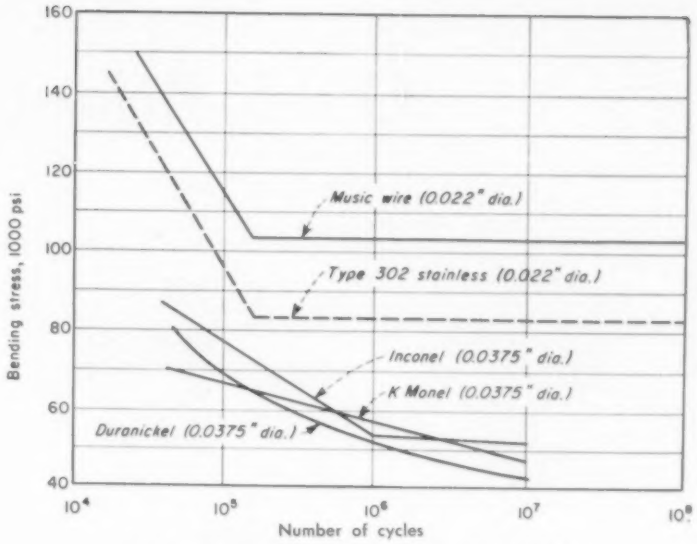


Fig. 6—Typical S-N curves based on reverse bending tests. Preloaded springs can withstand higher stresses.

FATIGUE PROPERTIES

Endurance limit and fatigue strength of the nickel alloys, determined in air at room temperature, are considerably lower than similar values for steels, as seen in Table I and Fig. 6. Also, shot peening, which is widely used to increase the allowable design stresses and endurance limit of steel wires is not equally effective with the nickel alloys. Fatigue properties of nickel can be increased only by approximately 30 per cent by this method whereas increases up to 100 per cent are possible with steels.

For corrosive conditions, shot peening with steel shot is not generally recommended since steel particles tend to become embedded in the wire and then act as focal points for concentration cell corrosion. Also, shot peening is not as effective with extension and close wound-torsion springs as it is with compression springs since the shot may not reach the inside diameter or inside surfaces of such springs. On close wound springs shot tends to stick between the coils and must then be removed by wire brushing.

EDITOR'S NOTE—Since spring design is one of the common denominators in the field of *Product Engineering*—and tends to be both complex and time consuming—recent issues have included a series of articles on design calculations for various types:

Design of Double Springs, September 1955 page 209. A reference book sheet with an extensive tabulation and a carefully worked-out example.

Torsion Spring Design, June 1955 page 136. Step-by-step procedure with moment charts and nomographs that replace trial-and error calculations.

Calculating Dimensions of Belleville Disk Springs, 1955 Annual Digest, page F29. Graphical design data and a large fold-out nomogram relating load, stress, deflection and washer dimension for steel.

Design Charts for Rectangular Wire Helical Springs, 1955 Annual Digest, page F37. Large design chart and corrections for trapezoidal sections.

Proportioning Helical Springs for Minimum Weight, November 1954 page 193. Simplified design calculations for this common requirement.

Constant Force Compression Springs, September 1954 page 129. A new system based on bending the axis of a close wound coil spring; adaptable to increasing, decreasing or constant deflection rate.

New Approach to Compression Spring Design, 1954 Annual Digest, page F24. Selecting the optimum spring design when application fixes material, space and load requirements; design chart and typical examples.

Check List for Springs, September 1953 page 185. Standard specifications based on practices used by Ford Motor Company for helical, flat wire and Belleville springs.

Dimensional Allowances for Helical Wire Springs, March 1953 page 207. Simplified procedure and a series of large charts.

Dynamic loading of springs introduces complex problems in determining stresses and deflections as a result of surge. The following recent articles have presented latest concepts in calculating dynamic performance:

Response of Dynamic Systems, April 1955 page 150. Simple tabular method for solving motion equations of dynamic systems for periodic, non-periodic and impulse forces—with and without damping.

Dynamic Loading of Compression Springs, a series of two articles in January 1954 page 162, and March 1955 page 162. General theory of elastic waves as applied to helical compression springs, fundamentals and application of the surge wave concept, and relation between harmonic vibration and surge waves.

Dynamics of Spring Motion, 1955 Annual Digest, page F21. Graphical method for obtaining instantaneous values of time, velocity and acceleration for the end of a spring at any position of stroke.

Several recent developments in materials for spring applications bring new possible solutions to difficult design problems:

Constant Modulus Alloy for Elastic Elements, July 1956 page 135. A hardenable high-strength and heat-resistant nickel chromium alloy that maintains constant elastic modulus over the range from —50 to 150 F.

Plastic Springs, June 1956 page 183. Methods of manufacture developed at NBS for helical compression springs for use at 135 F; torsional elastic properties and design stresses.

Quick-Release Fasteners

MARK LEVINE, Project Engineer, Grant Pulley & Hardware Corp.

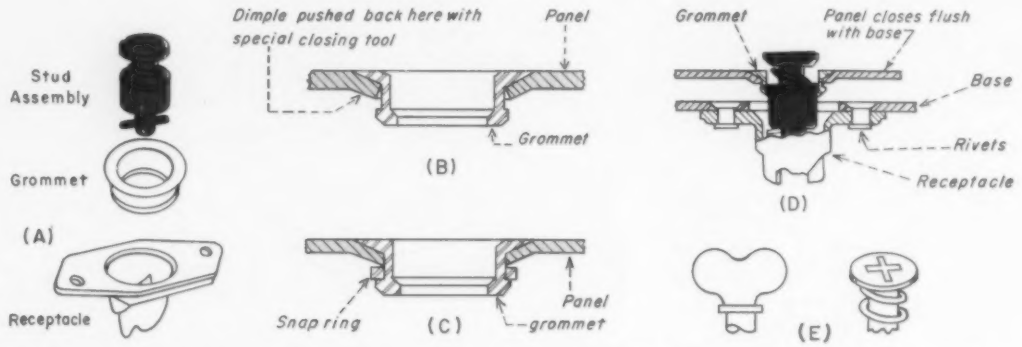


FIG. 1—GENERAL-PURPOSE FASTENER composed of (A) stud assembly, grommet and receptacle. Grommet secured to removable panel by dimpling or countersinking panel and then (B) pushing dimple back with special closing tool or (C) using snap ring. Receptacle is fastened to underside of base of cabinet (D) with two rivets. Locks or unlocks with quarter turn. Fabrication required: one large hole and two countersunk holes in base; one dimpled or countersunk hole in panel. Studs (E) also available with winged or cross-recessed head. Tension and shear strength: 700 to 1200 lb depending on size. *Camlock Fastener Corporation.*

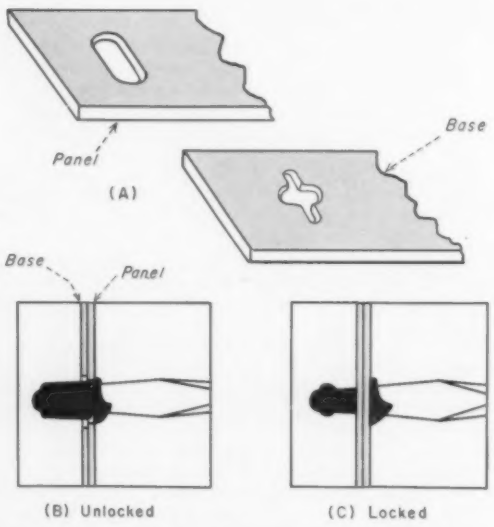


FIG. 2—SCREW-TYPE FASTENER requires special-shaped holes (A) in panel and base. Dies for piercing holes available from manufacturer. Inserted through panel and base (B) and locked (C) with quarter turn. Inexpensive but not self-retained to panel when unlocked. Available with special-shaped heads for supporting shelves. *Simmons Fastener Corporation.*

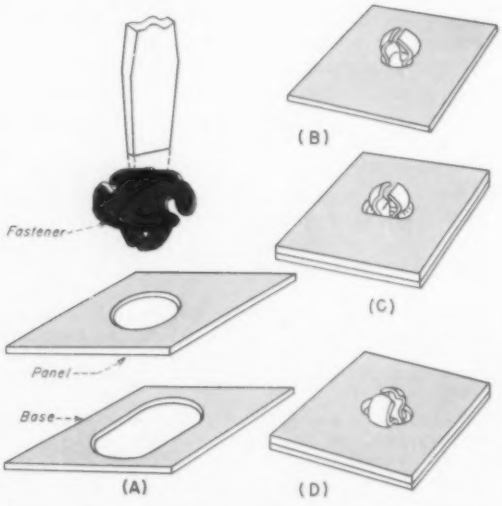


FIG. 3—ONE-PIECE FASTENER very low in cost but requires special hole (A) in base. Snaps into panel hole (B) where it is retained in place, then passes through elongated hole (C) of base. Quarter turn (D) locks panel to base but fastener can be turned past quarter turn position unless panel is dimpled for a stop. *Shakeproof, Division of Illinois Tool Works.*

Seven types of fasteners that engage or disengage with a partial twist—usually a quarter turn—as contrasted to fasteners that require several turns.

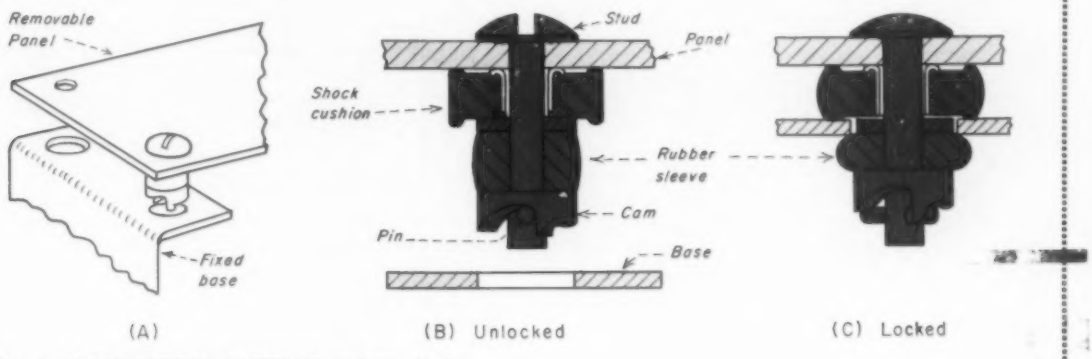


FIG. 4—SHOCK-MOUNT FASTENER reduces shock, vibration and noise between panel and fixed base (A). One hole drilled or pierced in both panel and base. Fastener permanently attached to panel (B) by assembling components and inserting pin with special pliers. Half turn of stud locks panel to base (C) by compressing rubber sleeve against base. Base "floats" between rubber sleeve and shock cushion. *The General Tire & Rubber Co.*

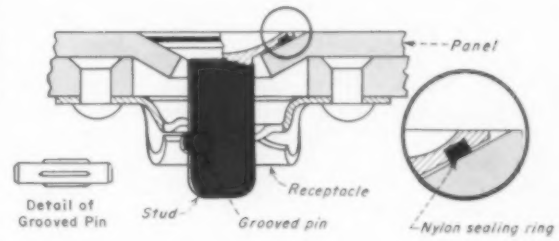


FIG. 5—SEALING FASTENER for moisture and pressure sealing has nylon sealing ring held captive in groove on underside of stud head. Fabrication requirements similar to fastener in Fig. 1—two counter sunk holes and large hole in base; one dimpled or countersunk hole in panel. Grooved pin supplied separately and driven into stud during installation. *Manadnock Mills.*

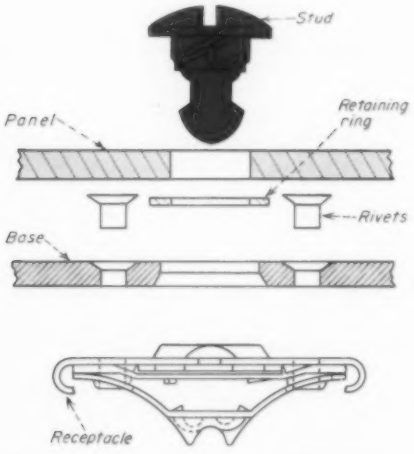


FIG. 6—HIGH-STRENGTH FASTENER has load capacity up to 3,000 lb in tension—4,750 lb in shear. Stud captivated to panel by retaining ring. Base drilled and countersunk for two rivets and to accurate dimensions in receptacle. Special countersink tool available from manufacturer for countersinking receptacle. Locks or unlocks with quarter turn. Up to 0.125 in. misalignment and 0.030 take-up permissible. *Southco Division, South Chester Corporation.*

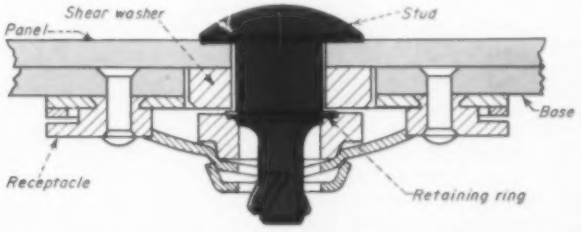


FIG. 7—HIGH-SHEAR FASTENER prevents shift between panel and base when carrying shear loads. Shear washer held captive to stud with retaining ring installed during panel assembly. Hole in base pierced or drilled to outside dimension of shear washer using close tolerances. Close fit between washer and hole necessary to reduce shifting of panel under shear load. Base also requires two countersunk holes for receptacle. Locks or unlocks with quarter turn. *Scovill Manufacturing Company.*

International Engineering for a Profit

Patent license agreements with foreign countries; the Technical Service Contract and what it contains; working with foreign companies; effect of the anti-trust laws.

H. A. TOULMIN, JR., PATENT ATTORNEY

Content of a Typical Technical Service Contract

PREAMBLE
Purposes of the agreement

SECTION I
General Conditions and Principles of the Agreement

SECTION II
Cross Patent Licenses: Advice as to Developments, Consultations as to Patenting

SECTION III
Engineering Information Exchange: Engineering, Patent

SECTION IV
Production Information Exchange

SECTION V
Personnel Exchange

SECTION VI
Money Payments and Exchange: Accounts and Reports

SECTION VII
Arbitration and Settling of Disputes

SECTION VIII
Enforcement of Litigation Against Third Parties

SECTION IX
Secret and Confidential Data

SECTION X
Geographical Scope: Admission of Other Parties to Agreement

PROFITABLE IDEAS are profitable in any language; there is no guarantee that the United States will get all the bright ideas and inventions. Indeed, during recent years, some of the greatest developments have taken place overseas. The question is: how can we best team together brains of Europe and the United States? How can we do our share of contributing our achievements to the promotion of international trade?

The Technical Service Contract

The answer lies in several different directions. First, patent license agreements furnish one of the cheapest and most effective ways to bring about this interchange of engineering information as well as manufacturing know-how. What is known as the "Technical Service Contract" (TSC) accomplishes this objective. This contract is a combination of a patent license or cross-license under one or more patents, and a plan by which engineering know-how used by a manufacturer is made a part of the patent license. An outline of a typical contract is shown in the box on this page.

Under this contract, the drawings, manufacturing instructions, test data, sales manuals and sales plans are delivered to the licensee. Along with this, engineers and production men go into the plant overseas and actually put the patents into production. In some instances whole plants are designed, and the machinery ordered and shipped overseas.

The practice works both ways. For example, a British company manufacturing eye-glass lenses for the local market developed a bifocal lens and unique methods of making it. The British company entered into a TSC with an American manufacturer by which licenses were granted under the American patents. The British factory manager was loaned to the American company, special machinery was imported, manufacturing methods were duplicated, and the American manufacturer proceeded to tool-up for production.

At first the lenses were imported despite the high tariff, and were used to develop the market; but as soon as the American sales grew to sufficient size, importing was stopped and manufacturing continued in the United States.

Often the TSC is a two-way affair; each party has a group of patents and cross-licenses the other. Additional inventions are then automatically cross-licensed. Generally speaking, in Europe there is no mass production as in the United States, but Europe is rapidly becoming a

dominating factor in inventive engineering, research and development work.

Success of a TSC is determined largely by the human element. The social and public relations aspects are the key. Information, often confidential or secret, must be furnished by both parties. Differences of language and temperament must be overcome. Men must be sent at the expense of the other party to help install the new developments. New customs and social obligation must be managed. This takes patience, skill, and imagination, as well as tolerance. It is particularly the forte of engineer diplomats who can talk with men who do not speak their language by making an engineering drawing.

One important point: personalities of the engineers and the industrial executives can make or break such deals. The U.S. has had its share of shortsighted temperaments, and foreign nations are not exempt from this disease. Each group must learn to yield natural and national prejudices.

An example of what the combined engineering brains of two countries can produce is the hydraulic torque converter which had its origin in Germany. At first, the units were exported to the United States; most U.S. naval vessels prior to the last war were equipped with these German-made torque converters. As a result of a technical service contract between a U.S. company and a German company, hydraulic couplings and torque converters of U.S. manufacture are now used on all automotive and many types of industrial equipment.

Advantages of International License Contracts

These bring together different points of view, different educations, and different resources of knowledge from different kinds of manufacturing in foreign countries. They also lend new dignity and importance to the engineering profession. Corporate management will therefore find it a rewarding industrial experience. Control of competition is an integral factor and requires careful legal advice of a highly specialized type to avoid conflict with the Sherman Anti-Trust Laws and other legislation.

With patent licenses overseas, competition can be controlled legally by requiring a return under the patents for whatever is sold by the licensee. Again, by having foreign patents, a company can export into countries where it has patents with greater freedom and less likelihood of patent infringement suits. If some conflict does arise, the foreign patents can be used as trading material for a license under the patents of the foreign competitor.

Patents taken out in the United States can be used to stop imports of infringing machines; foreign patents can be used to stop infringing imports from foreign countries. But more important, patents can be filed first in the United States, giving far more protection than the Tariff Acts.

In the field of international engineering, the problems of the sales department are important also. The universal language in selling is the trademark, and it too can be protected by registrations of trademark rights. It is customary, therefore, in most technical service agreements to include trademark rights.

Often, the choice is between outwitting a foreign competitor or pooling of interests. With technical conflicts settled, each group can concentrate on manufacturing and selling at a profit. When export into one country is profitless because of difficulties of language, distribution or service, a foreign manufacturing partner in another nation may offer a connection. For instance, Europeans generally are cool to the idea of American chemical engineering in chemical fields, preferring the "chemist-process-engineer team" system. These differences may be reconciled by licensing or cross-licensing.

Anti-Trust Laws

One of the barriers to international cooperation is the Anti-Trust laws of the United States. Cross-licenses combined with agreement upon prices violates the Anti-Trust Laws, although prices can be fixed without consulting with the licensee. The patent license cannot be used as an excuse to control methods of distribution to exclude others from certain geographical territories, or otherwise control commercial matters under the guise of patent licenses. The only thing possible is to control that which comes within the patents and nothing more. The danger lies in trying to monopolize, by exclusive cross-license arrangement, all of the art in a given field and thereby in effect restrict all competition to those who are cross-licensed.

International cartels violate the Anti-Trust Laws of the United States but are legitimate overseas. There is a tendency in Great Britain to take the same position, and for a while in Germany after the war under occupational influences, German Anti-Trust Laws like those in the United States, were being enforced. They are now being abandoned gradually. The practical requirements of Europe made international cartels an attractive method of doing business, with which Europe is familiar and from which it has drawn great prosperity.

The U.S. is inflexible in its worship of the Anti-Trust Laws, and in that area it is not internationally minded, despite all the public protests made to the contrary. For instance, the U.S. oil companies, in cooperating as a group with oil companies of foreign countries, have run into Anti-Trust trouble frequently. The same thing has happened in the chemical engineering field between the chemical companies of England and Europe and those in the United States and Canada.

Influence of Patent Laws

The new U.S. Patent Law of 1952-3 has some provisions that must be carefully respected. In the first place, a patent application cannot be filed overseas within the first six months after it is filed in the United States without a special license from the government. In many instances, there is subject matter, such as atomic energy, that cannot be licensed overseas even after the six months without special license. It is also advisable to carefully explore approval to enter into such interlocking contracts, consulting United States government sources, particularly the Attorney General.

Inventions that fall within the secrecy class, and are so designated by one of the Armed Services, are impounded in Division 70 in the Patent Office and placed under or-

ders of secrecy so that nothing can be said about them until they are released.

The United States has joined most of the leading countries in a series of international treaties known as "International Conventions", dealing with industrial property rights, such as patents, which date back to 1883. These treaties must be taken into account because they determine the reciprocal patent and trademark rights of nationals whose governments have signed the treaties.

When a foreign application is filed in the United States, it can claim the benefit of the filing date in the foreign country as its date of invention when the application is filed within the year of its filing in a foreign patent office. United States inventors have the same right when filing an application abroad based upon a United States application. If the application is filed after the first year, then the date of invention in the country other than that of the inventor, will be the date of filing in the foreign country.

Before filing abroad, the application must have been filed in the United States for six months unless there is a special license to anticipate the expiration of the six months; and in the case of certain countries, even after the six months a special license must be secured for exporting the information.

These rules are also modified by the fact that the applications filed in different countries must be identical to have advantage of the dates of invention as indicated above. Here trouble arises in the case of certain pharmaceuticals and food products which are legal in the United States but which may not be legally patented abroad.

For example, an European national may not be able to take out a patent in his own country on a pharmaceutical product, but can take out a patent on the process of making it. If he failed in the United States and claimed both the article and the process, he could not get the benefit of the home date of filing on the article, because his home country does not give reciprocal rights in patenting the pharmaceutical article in his home country.

International Trade Laws

International engineering and the exchange of information is greatly restricted and must be carefully guided through laws enacted under International Conventions for

Project Group vs Service Group in Engineering Development

A. H. KURILOFF

The author is Design Group Engineer for the Electronics and Engineering Laboratories at Convair in San Diego. His earlier experience with smaller engineering departments was as chief engineer of Harvey Machine Company's Research and Development Division at Torrance, Cal., and as chief engineer at Bill Jack Scientific Company, Solana Beach, Calif.

His twenty years' experience with the organization of development work has been about equally divided between the two systems he describes.

IN MOST COMPANIES the engineering development task is accomplished under either a project group or a service group system of operation. A general understanding of the principles inherent in these methods should lead to greater success in the employment of either.

Project group system is one in which a group of engineers is gathered together under a project engineer. The group is responsible for the entire job, from initial layouts to final acceptance.

Service group system employs the efforts of groups of engineering specialists, each responsible for a specific phase of the task, but each group operating under its own boss. The total task is managed by a project engineer.

Effect of Size of Company

The size of the company is of great significance in selecting the operational method. The larger the company, the greater the chance that it will tackle more and more complex engineering development jobs. This trend results in considerable diversity of engineering skills. Thus, specialized groups of engineers tend to form under leaders qualified in particular fields. A staff, or service group, method automatically results.

It devolves upon a project leader, selected from a specially qualified project engineering group, to organize, control and manage the course of the job through the various service groups. The project leader must be extraordinarily skillful and experienced to accomplish his job profitably.

In a smaller company the tendency is to staff the engineering force with well-rounded, more widely experienced men. Usually each will have additional strength within certain specialized regions of engineering.

The smaller company will also tend to occuy itself with fewer and less complex development tasks. The normal trend is toward the project group system wherein one engineer is designated project engineer for the task in hand. A group is selected to work with him from start to finish of the project. All phases of the engineering task are carried out within the group.

Effect of Management

Management of the smaller company will generally be more knowledgeable in the technical requirements of development work, being several echelons closer to it than in the larger company. It will therefore tend to gravitate naturally toward the project group system, knowing inti-

the protection of industrial property. Some portions of these Conventions have not been fully carried out by legislation in the respective countries, which is another factor that has to be checked.

Recognizing the importance to the United States of international trade in engineered products, Congress enacted some years ago the Webb-Pomerine Act which permits companies to join in a common enterprise in order to meet foreign competition. Under this law any person, firm or corporation may combine with others in the same or different trades, whether competitive or not, to form an association for foreign trading which includes licensing and technical service agreements.

So long as there is no restraint of our export trade and no agreement on prices in the United States to lessen competition here, then such an associatoin is exempt from the Anti-Trust Laws of the United States. Such associations often control 100 per cent of the exports of their members; the association has representatives abroad to handle the business of the members with stocks being carried abroad in warehouses owned by the association.

Such associations often amount, in fact, to price cartels. The establishment of prices is often regarded as a distinct function of the associations, the prices depending upon economic conditions in each market. The Webb-Pomerine Act is in effect a "counter cartel." The United States has been forced into such an arrangement to protect its domestic and foreign trade. Such an arrangement can be most effective when there is combined with it these technical service contracts.

Use of arbitration provisions in an overseas contract is a vital one in settling misunderstandings and difficulties. Currency and terms of payment of royalties and technical payments are another problem. As currency restrictions decrease, the problem becomes less serious. However, it is frequently advisable to accept the currency of the country abroad as a diplomatic expression of confidence.

International engineering is confronted with the problem of importing engineers from overseas, making TSC agreements, or relying upon some overseas research foundations instead of establishing a research laboratory in a foreign country. With the Technical Service Contract and patent license exchange, each company can employ its nationals to the fullest extent in a healthy atmosphere.

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mately the temper and quality of its men.

Management of a larger company is farther removed from its engineers, usually both in time and space. Accustomed to the normal routine of remote control, it tends to adopt a service group pattern in the prosecution of development tasks.

Comparative Efficiencies

Efficiency of the engineering development operation is based upon four variables: morale, ease of communication management of time and money, and ability to solve extraordinary technical problems.

Morale may be most readily maintained in a small group, whose single purpose is to accomplish a single task. The skill of the project leader in the service group system will be taxed in this regard, since he is competing with leaders of other development tasks in wooing the best efforts for his own project from the various groups. The project team is clearly superior here.

Communication is simpler and more direct within a project group. The lines of contact are short. No special methods are required to disseminate vital data daily throughout the group. The men are close to each other. Consequently teamwork is spontaneous.

Management of time and money is more readily accomplished within a project group, where all the men are engaged on a single job. The project engineer knows continuously the status of progress and expenditure.

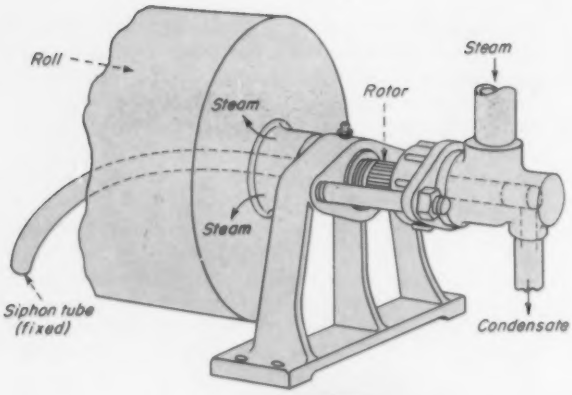
In the service group system, on the other hand, these factors must be determined by collection of data from several service groups. The supervisor is forced to spend considerable time and energy in this analysis. He is thereby diverted from the technical prosecution of the job. Diligence in the maintenance of these managerial records is more important here than in the project system, since it is usually only by a flow of status reports that he is known and can justify his labors to management.

Unusual technical problems often must be solved before the main task can be completed. Here the strength of the service group system becomes apparent. It is merely necessary for the project leader to assign the problem to that service group most capable of solving it. In the project group, the problem would be assigned to the man most capable of handling it. The solution may be arrived at quickly, but it is more likely to be a more laborious task than if undertaken by a specialized group.

Enthusiastic Leadership Is the Key Element

It would seem that the project group system has more advantages than the service group system. This, however, need not be the case. Careful examination of the factors enumerated show that the service group approach can be equally successful, providing care is taken to avoid its pitfalls.

A wise project engineer, operating under the service group system, will select a competent administrative assistant to collect data continuously, to monitor the expenditure of time and money, and to keep the channels of communication flowing. This leaves him free to consider all ramifications of the technical work. Conversely, the project engineer, if his talents so incline, can perform the administrative function and rely on a competent technical assistant to handle the engineering problems. In either event, morale should be maintained by intimate contact with the men throughout the job. The result of this kind of good leadership is the transference of enthusiasm by association. Good morale, thus engendered, can move mountains.



ROTATING JOINTS

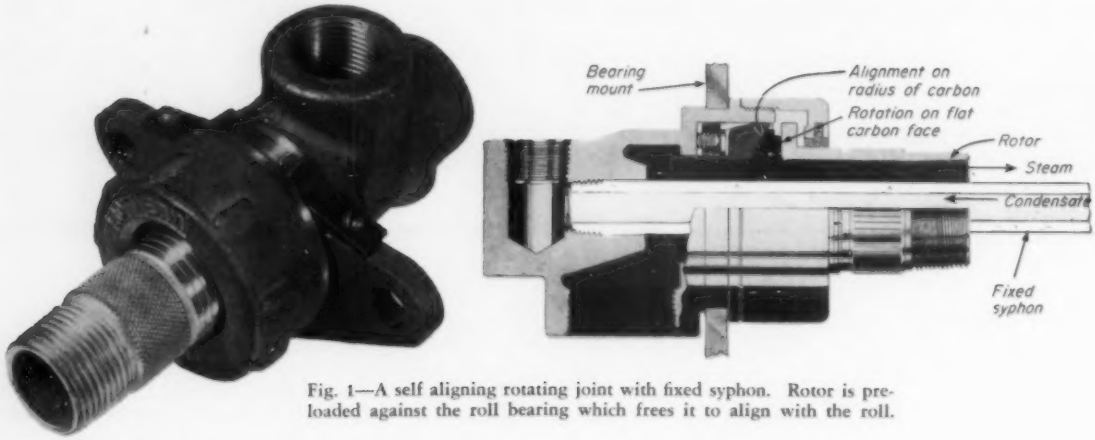


Fig. 1—A self aligning rotating joint with fixed syphon. Rotor is preloaded against the roll bearing which frees it to align with the roll.

Seal materials, design of self-aligning and self-supporting units, multiple passage joints and their applications to vapor systems and other industrial service

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ROTATING JOINTS, originally designed around the familiar packing gland, have become highly specialized for many applications in all industries. Improvements in polished rotating surfaces, better packing materials and closer machining tolerances have all contributed to increasing use of these components.

However, varied applications compound the problem of effecting a flow of fluid through one or more independent passages to a rotating member. Fluid carried, speed of rotation, external atmosphere, temperature, pressure and even the difference in service personnel have resulted in almost as many kinds of rotating joints as there are valves.

Rotating joints are now operating from —300 F (liquid oxygen) to 700 F (dichlorobenzene) or high temperature superheated steam. They handle water, steam, brine, air, paint, lacquers, refrigerants, diphenol-diphenoloxides, dichlorobenzene, sea water, and air-mud mixtures.

SEALS. The seal is the heart of the rotating joint. Many materials are used but the carbon ring seems to be most practical. They may be designed to take thrust loading as well as perform sealing functions. Carbon seals may be divided into the various hardness groups, porous seals, partly impervious, entirely impervious and others. Porous seals permit some seepage and depend on this seepage for lubrication.

Some impervious carbon seals may be operated at very high speeds without lubrication. Research on ceramic and lava seals indicates strong dependence on carbon type, service requirements and seal design. The compressive strength of these seals is much higher than the tensile strength and so the design must take this into account to limit damage from shock and pressure thrust that develops in many applications.

Stainless steel, Monel and high nickel steel make good mating surfaces for carbon seals. However, these are fairly costly. For lower cost a chrome plated low carbon steel makes a good sealing surface. Accuracy in machining and lapping the surface before plating is important since

the deposited chrome will build up on any edges and later wear the carbon very quickly. When porous carbons are used and joints are stored in a stock room or mounted on machines that stand idle, pitting of the chrome surface develops. This is especially serious in the presence of sulphur treated packings. Seepage between carbon and rotor face traps moisture and starts corrosion. Therefore, continuously operated rotating joints are apt to give better service than intermittently operated components.

Electrolysis will also cause pitting of steel against carbon during storage. Chrome, boron, tungsten, molybdenum, and vanadium show less tendency toward this form of corrosion.

Teflon makes a good stationary or slowly rotating seal if properly designed for the job since it is chemically inert and able to withstand high temperature. Other types include rubber O-rings, chevron rings and metallic packings. None of these are suitable for high speed rotation.

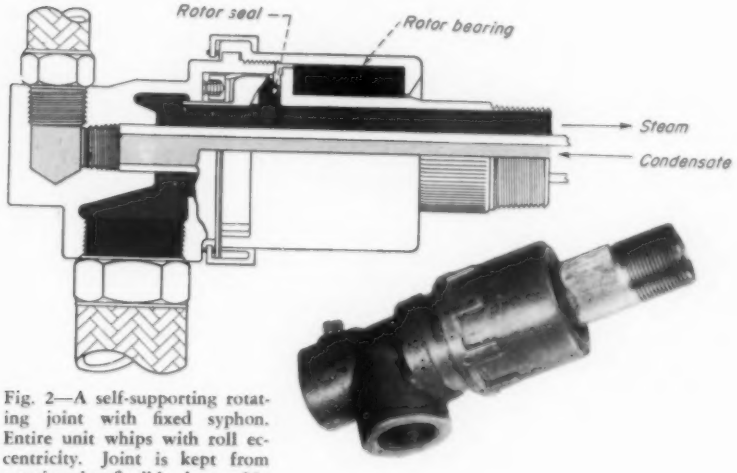


Fig. 2—A self-supporting rotating joint with fixed syphon. Entire unit whips with roll eccentricity. Joint is kept from rotating by flexible hose. No additional support is required.

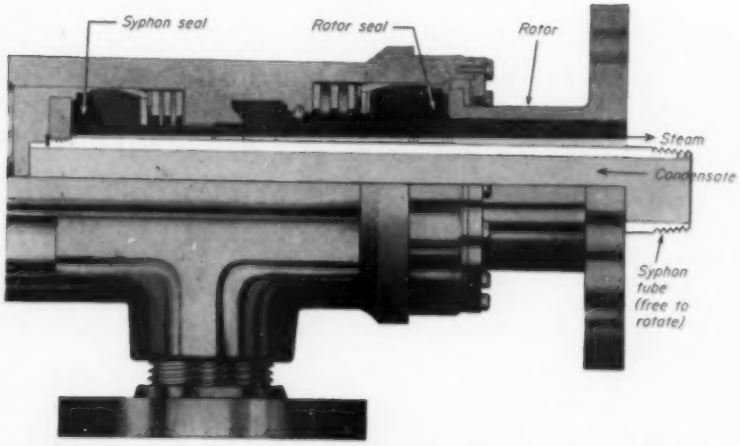


Fig. 3—Both rotor and syphon can rotate independently in this design. Eccentricity is taken up in two facing seals. Both rotor and syphon must be preloaded against their springs. External shell requires rigid mounting to base of machine.

DESIGN. Roll concentricity, (concentricity of rotating member to which fluid is being carried) end thrust and expansion have an important part in the service that can be expected. Joints designed to compensate for roll misalignment, expansion and end thrust can be mounted with fixed piping. In this type of joint it is necessary to preload the joint against the roll bearing so that the rotor can float to its own center. Fig. 1 shows how the rotor compresses a seal spring. The syphon tube is fixed and clear of all rotating parts. No strain is transmitted to the syphon tube and the rotor aligns itself with the roll.

Most rotating joints are self-supporting and require attachment of flexible hose or copper tubing as shown in Fig. 2. The flexible hose keeps the stator from rotating and the joint is free to whip with the roll eccentricity. The joint must be rugged enough to take this abuse over long periods of time.

These two types are designated as self-aligning and self-supporting rotating joints. The self-aligning unit requires rigid mounting to the frame of a machine to permit free floating of the rotor. The self-supporting unit has a bearing or bushing built in. The rotor and syphon tube of a self-supporting unit wobble with the roll eccentricity, and fatigue set-up by this strain shortens syphon tube life somewhat. The syphon tube in the self-aligning unit is screwed to the rigidly held portion of the joint.

Rotating joints are now being made that compensate for eccentricity of both rotor and syphon tube. These joints must be mounted rigidly with bracket supports. Fig. 3 shows how two independent seals of the self-alignment type act in a joint of this kind.

Accurate machining and concentricity are important in the equipment on which joints are used. This is especially true when the joint has more than one rotating member. The outer rotor, being the strongest, must find a center of rotation within which inner rotors can revolve without interference.

In the design of multiple passage joints all rotating members must be accurately machined and fitted. End length is critical except where the design permits such variation. The outer rotor must not be permitted to set up strains in the threads of the smaller rotary members.

Increased production requirements in textile, paper and

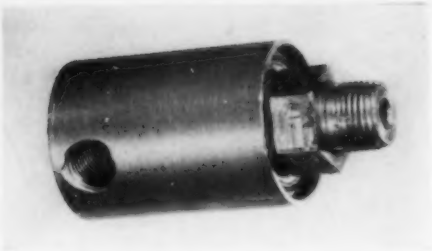


Fig. 5—High speed single passage rotating joint for air brakes, fluid brakes and clutches.

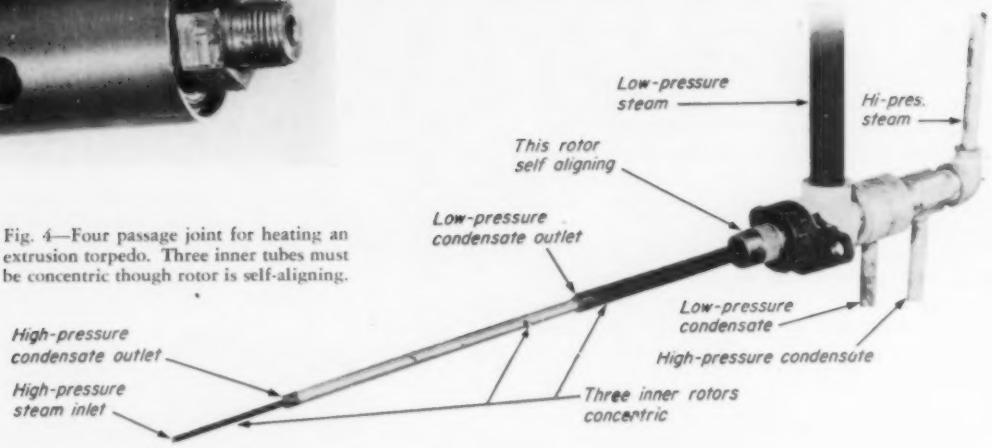


Fig. 4—Four passage joint for heating an extrusion torpedo. Three inner tubes must be concentric though rotor is self-aligning.

rubber industries have resulted in higher temperatures, pressures and rotating speeds of drying rolls. Torque is consequently of increased importance in the design of rotating joints for these applications.

Lowest torque is achieved in the self-aligning joint. The rotor is free to float unhindered and friction torque is determined by spring pressure and contained fluid pressure. The self-supporting joint must whip with the eccentricity of the roll and additional friction is bound to be generated.

Balanced pressure joints have been designed, though they become somewhat complicated. Some reduction in torque has been accomplished with compensators that take pressure from the feed line and apply it to the back of the joint to balance end thrust from internal joint pressure. Additional research in this field is still required.

APPLICATIONS

Steam joints are used on various machines in paper mills, textile plants, plastic plants, rubber plants, paper finishing plants and others. In the paper industry rotating joints are used on machines for the processing as well as manufacturing of paper such as paper finishing, waxing, corrugating, printing, lithographing, crimping and tissue processing. In the textile field rotating joints are used on machines for sanforizing, finishing with various lacquers, waxing, printing and dyeing. Rotating joints are used in the wheat fields on grain drying equipment. Many of these processes require the web of moving material to drive the roll, and so joints and roll bearings must not impose high torque on the roll. Joints used on yankee dryers must compensate for roll expansion as well as misalignment.

In many plants, processing and coating of fabrics and paper make it necessary to air condition the entire plant to assure a continuously uniform product. Leakage of steam joints would upset the humidity and air conditioning of the room. Processing is often done under ultra high vacuum. If the quality of the product is not to be affected, fittings and rotating joints, valves and all other accessories must be leakproof.

Industries using high temperature rolls experience considerable difficulty with misalignment of the thread into which the rotor of the rotating joint is fastened. This is caused by non-uniformity of threads, variable end thrust on bearings during heating and cooling periods when roll expands or contracts, and even poor initial bearing alignment. Under high temperatures the metal stresses are partially relieved and some permanent metal strain may occur which will eventually appear as misalignment of the ends of the roll. Whipping of the rotating joints should be held to a minimum by proper roll alignment, frequent inspection to insure that bearings are in good condition, and by keeping end thrust on roll to a minimum.

Sectional heating and cooling of extrusion torpedoes are accomplished by joints with many rotating members as shown in Fig. 4. Low pressure steam is introduced into the back end of the torpedo and the condensate returned around this feed pipe. High pressure steam is introduced into the far end of the torpedo through the inner rotating members and the condensate returned around this high pressure feed line, all passages are introduced and returned through the same end of the torpedo.

Air and hydraulic joints for brakes and clutches have single or double passages for pressures from 5 to 3,000 psi at speeds to 8,000 rpm. A single passage joint is shown in Fig. 5. Some of these joints must withstand up to 2,500 lbs end thrust while under rotation. Rotating joints are used to carry coolant for high speed drills on deep drilling operations.

Automation is developing many rotating joint applications. In foundries they are required to carry air or hydraulic fluids through several passages while subjected to high pressure, extreme heat and excessive dirt and dust accumulation. Rotating joints are used to feed air or hydraulic fluids to cylinders mounted on the periphery of a rotating assembly table to grip or release work for various operations. Rotating joints carry oxygen into

rebreather systems in aircraft gun turrets, gun turrets on board ship, sonar equipment for submarine detecting and stop fire arrangements.

Other industries require joints for handling refrigerants, such as ethylene glycol, ammonia, sulphur dioxide, and brine solutions, as in the manufacture of soap flakes and soap buds. The refrigeration application shown in Fig. 6 has an independently mounted joint. In the manufacture of dry milk, coffee buds, or orange powders steam is used to bring the liquids to a boil while chilling rolls cool the hot liquid causing buds and bubbles to form. In some processes this is done under ultra high vacuum.

Joints for refrigerants or in high vacuum service require exceptionally fine lapping of all surfaces. They must be absolutely free of any scratches, flat and of a very high polish. Carbon seals with various impregnants are used.

Porous metals give excellent service in contact with liquid oxygen or liquid methane at temperatures as low as −250 to −300 F. The fluid medium has a tendency to seep into the pores of the metal and freeze to form its own seal. Special springs must be used at these temperatures.

In the cereal industry rotating joints are subjected to very severe service on cereal guns for manufacture of puffed cereals. They handle steam at temperatures over 500 F in combination with oil and salt solutions. Grains are impregnated with steam under high pressure. They are then fired from the guns and expand due to internal pressure. Gun recoils are hard on the revolving joint.

High pressure water systems are used on calenders, mills and rolls and large size rotating joints are usually required. Joints should be used that can be either anchored to the roll bearings or enough flexible hose provided to permit freedom of movement as these machines are sometimes subjected to severe shock and roll vibration. When the joint is anchored to the roll bearing sufficient flexibility of piping or flexible hose is required to permit roll adjustment for various thicknesses of material handled.

Multiple passage joints are used on paint spray machines to handle all sorts of lacquers and air through the same unit without permitting air to penetrate the lacquer tanks. They are used on bottle fillers in breweries to handle carbon dioxide through one passage and air through two other passages.

Rotating joints handle sea water for cooling of heat exchangers. Fuel lines are carried through the center of rotation.

VAPOR SYSTEMS

In vapor systems it is imperative that the rotating joint have a second connection for venting air from the roll. In steam systems this is called the syphon tube and is inserted so that the tube is directed to the bottom of the roll. Condensate is removed through the same tube as it collects at the bottom of the roll.

Diphenol-diphenoloxides, and dichlorobenzene (Dowtherm) are heavier than air. Air is forced to the top of the roll and a secondary connection to this point is necessary for venting. The regular syphon tube may be turned so that it is near the top of the roll. The vapor inlet should be larger than those used for steam and since the absolute pressure drop is considerably greater the condensate removal pipe must also be larger. This type of system is often used to achieve a higher roll surface temperature. Due to these higher temperatures carbon seals, impregnated with antimony and antimony and copper may be required. However, copper is not recommended when the system is to be tested with ammonia. On the stationary seals, metallic packing is recommended for the high temperatures involved.

When heating rolls with oil it is recommended that larger piping feed lines and return lines be used than with steam. Because of the reluctance of the oil to disperse its

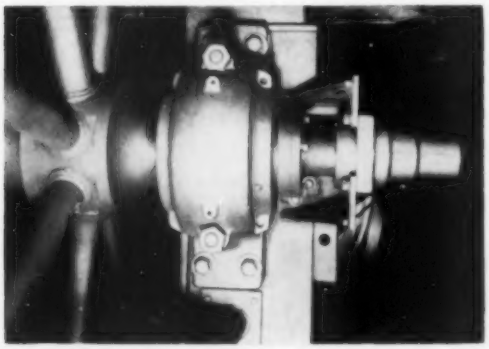


Fig. 6—Rotating joint for refrigeration application showing mounting brackets.

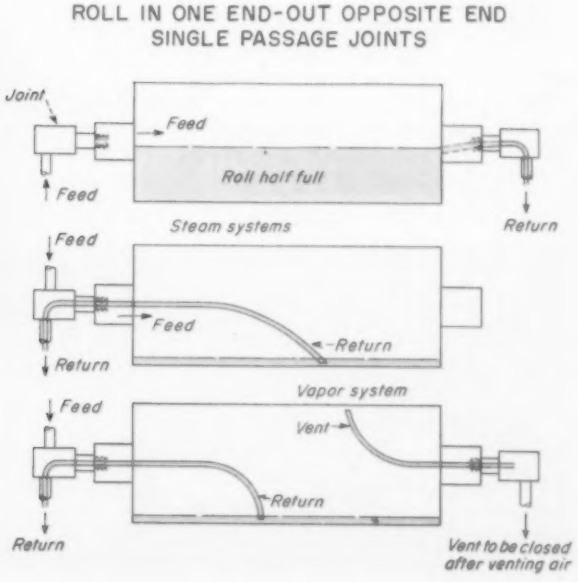


Fig. 7—Three methods of heating a roll. If return is taken from far end of roll (top), roll fills with water which cuts down heat transmission to surface of roll. With syphon tube (middle) accumulated water is kept to a minimum. Vent may be added for vapor system requiring removal of air (bottom).

heat larger volumes of oil pass through the system.

Many rolls are heated or cooled through joints at both ends of the roll through which the condensate or water can be returned or emptied. However, without a syphon tube water will collect until the roll is half full. Carried around the inside of the roll by centrifugal force water acts as an insulator impeding heat transfer. A better method is to return the condensate or water at the same end it is introduced with a syphon drawing condensate from roll bottom. Fig. 7 illustrates these methods.

For cooling rolls the syphon tube can be used as a feed pipe and it can be perforated along the top so as to spray cold water along the top inside of the roll. When introducing cooling water into a roll this feed line must pass through the heated return water. Joints are now made that have an insulating area between the feed and return lines so that the cooling water pipe is not warmed by the hot water return.

Stretched Plastics for Crack Resistance

EDWARD SCHIFF
Research Test Engineer, Convair

THE IDEA OF STRETCHING PLASTICS was born during World War II, when it was noticed that the crown of blown bubble aircraft canopies seemed more crack resistant. Since this was the most highly stretched area, experiments in stretching were conducted. Today, there are two general stretching methods: a mechanical system which uses hydraulic rams and grips around the periphery of a square sheet, and a blowing method in which a hemisphere or cylinder is blown and later flattened. With either system, temperature must be carefully controlled. If the temperature is too low, the plastic will "freeze" and tear during stretching; if it is too high, crack resistance will not be improved.

The result of the stretching process is illustrated in Fig. 1. On the left are two typical "as cast" window constructions: a 0.50 in. monolithic acrylic, and a laminate of 0.20 in. acrylic faces and a 0.20 in. polyvinyl butyral core. On the right is a typical stretched acrylic 0.35 in. thick. These specimens were placed on a table and a heavy spike hammered into them. The first cracked in two before the spike had penetrated halfway. The laminate was held together by the vinyl, but both face sheets split would certainly carry no structural load. The stretched specimen allowed full penetration with no emanating cracks.

The cause of improved cracking characteristics of stretched plastics is not fully understood. One theory is that the basic structure has been altered to produce a laminar molecular arrangement in the stretching plane. The long chain molecules formed in a random pattern during polymerization are believed drawn into realignment by the tensile loads during stretching, after heating has reduced the intermolecular forces. Stretched plastics would thus resist the spreading of cracks between molecular "layers", much the same as any laminate resists the spreading of cracks from one ply to the next. Evidence of this "layering" can be seen in the stratified appearance of failed test coupons. Block compression specimens actually "delaminate" upon failure, and flexural specimens indicate a similar tendency, as shown in Fig. 2. Another indication is the relatively low tensile shear strength parallel to the stretching plane; only 900 psi at 75 F for stretched Plexiglas 55, or about 10 per cent of the "as cast" value.

Some physical properties are improved by stretching. Fatigue strength is better, partly because of decreased notch sensitivity. The flexural characteristics are quite surprising. A simple beam of 0.35 in. thick stretched plexiglas 55, can be flexed over a 0.50 in. radius to 90 degrees without fracturing. This marked improvement over "as cast" material is not caused by a great increase in tensile or compressive strength; it is a matter of increased elongation, produced by the easier "sliding" of molecular chains upon one another when all are oriented in the stretching plane.

Craze resistance of stretched materials is improved, which should be anticipated, since crazing is simply a series of fine cracks. Many solvents that readily craze an "as cast" plastic at an outer fiber stress of 2,000 p. s. i., do not have any effect on the stretched material, even when stressed to 12,000 p.s.i. Most stretching development to date has been with Plexiglas II and Plexiglas 55.

Fig. 1

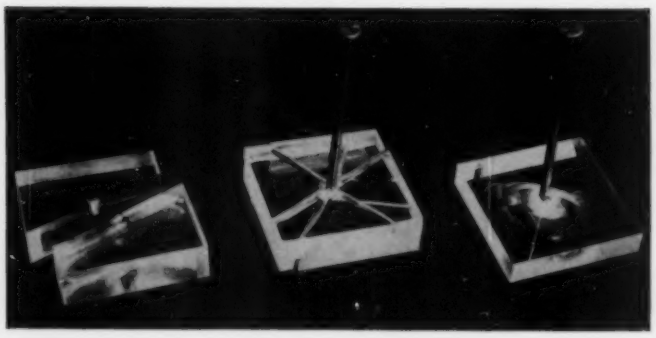
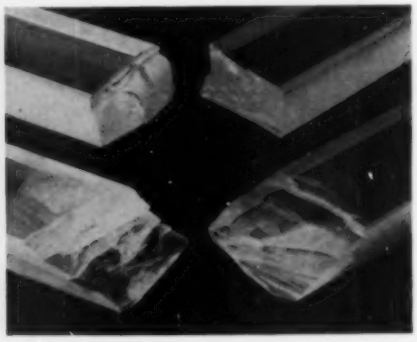


Fig. 2



THE SHORTAGE OF SCIENTISTS AND ENGINEERS:

A Threat to Economic Progress

THERE are two paramount reasons for concern over the serious shortage of scientists and engineers that now confronts the United States:

- The first reason, with which this editorial deals, is that continued expansion of our economy and further increases in our living standards are threatened unless we train more scientists and engineers and use them more effectively.
- The second reason for concern is that we run the risk of falling behind the Soviet Union in the technology so essential to national security. The consequences of losing this race to the Russians are not comforting. (The possibility that this might happen over the next few years was discussed in an earlier editorial in this series.)

The crucial contribution of scientists and engineers to the well-being of the American people has been to find ways of making better use of limited resources, to make equipment more productive, to develop new and better products that enrich our lives, to enable us to live longer and be healthier. They have made this contribution with greater success in the last 15 years than ever before, but it has required progressively more resources and more trained people.

During this 15-year period our annual production of goods and services, in dollars of constant purchasing power, has almost doubled. Since our total population has increased only 25 percent, this has meant a tremendous rise in the economic well-being of the American people as a whole. But in accomplishing this, the number of scientists and engineers has been more than doubled.

Tasks for Research

If the American economy is to continue to grow and if our living standards are to show further improvement, the work of scientists and engineers must be stepped up even more in the years ahead. Unless answers to several pressing problems are found through intensified research efforts, economic progress will become increasingly more difficult.

Productivity per hour of labor must be increased at a faster rate. Improved medical care has greatly increased the number of people who attain retirement age, and sharply higher birth rates since the war will mean larger numbers of children in school and college. Meantime, because of low birth rates during the depression, the number of people reaching working age is not rising nearly so fast. The result is that over the next 20 years our population will increase by about one-third, while the total manhours worked are not expected to increase more than 15 percent. So, simply to maintain the same living standards for a rising population — with no provision for additional improvements — ways must be found to enable each worker to produce for more dependents.

It is primarily to the scientists and engineers that we must look for help in making human labor more productive. This will require enormous increases in our power

resources. We will need to make more effective use of our existing fuel supplies — coal, oil and natural gas. And we will have to devise economically practical means of tapping other energy sources, particularly nuclear power and new rocket fuels.

Also, better ways must be found to use scarce and low-grade raw materials. Thanks to great strides in metallurgy and mining techniques, we are now utilizing sources of copper and iron ore that, for all practical purposes, were not available to us only ten years ago. Similar strides are needed in the mining and processing of bauxite if low-grade domestic ores are to help satisfy a fast-growing market for aluminum. And stubborn technical obstacles in the area of "high temperature" metals—such as nickel, cobalt, columbium, tantalum and titanium — are impeding progress in jet and turbine engines.

These are only a few of the challenging tasks that demand intensified research and engineering activity in the years immediately ahead if the United States is to continue to raise living standards. We need more houses, schools and highways for a rising population, more medical research to reduce further the ravages of illness, more research in chemistry and other sciences to sustain the flow of new and improved products that are so essential an ingredient of our economic progress.

Ceiling on Growth

American industry has indicated that it is ready to meet the challenge and undertake vastly expanded research programs. A recent survey conducted by the McGraw-Hill Department of Economics revealed that total research and development expenditures of American industry were almost $5 billion last year, 29% higher than in 1953. By 1959 business plans to be spending well over $6 billion on research and development. And the total could well prove to be much higher, based on the trend of recent years.

But industry's programs for research and development cannot be carried out unless enough qualified research workers and engineers are available. Ernest R. Breech, chairman of the Ford Motor Company, recently described the supply of engineers as the "ceiling on our future growth." He gave force to his point by announcing: "If 900 qualified engineers were to approach us next week looking for jobs, we would hire every one." The U. S. Bureau of Labor Statistics found in interviews with some 200 large companies at the end of 1954 — a recession year — that at least half were unable to hire enough research scientists and engineers to meet their needs. A third of the companies reported substantial shortages of technical personnel.

The shortage of technically trained people, furthermore, is becoming more acute. The number of engineers and scientists now being graduated is only about enough to cover replacement requirements, while the needs of industry, government and education are mounting every year. According to the best information available — as indicated in the first editorial in this series — these needs are now about twice as great as our current engineering graduating classes and annual production of scientists with Ph. D. degrees.

To perform the research needed to remove roadblocks to our economic progress — and at the same time hold our own in the technology essential to our security as a free nation — we must have an adequate supply of men and women with engineering and scientific training. Instead, we are faced with an acute shortage, now and for several years to come. Reasons for the shortage and proposals for working our way out of the shortage will be discussed in the remaining two editorials in this series.

This is one of a series of editorials prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nationwide developments of particular concern to the business and professional community served by our industrial and technical publications.

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Donald C. McGraw

PRESIDENT

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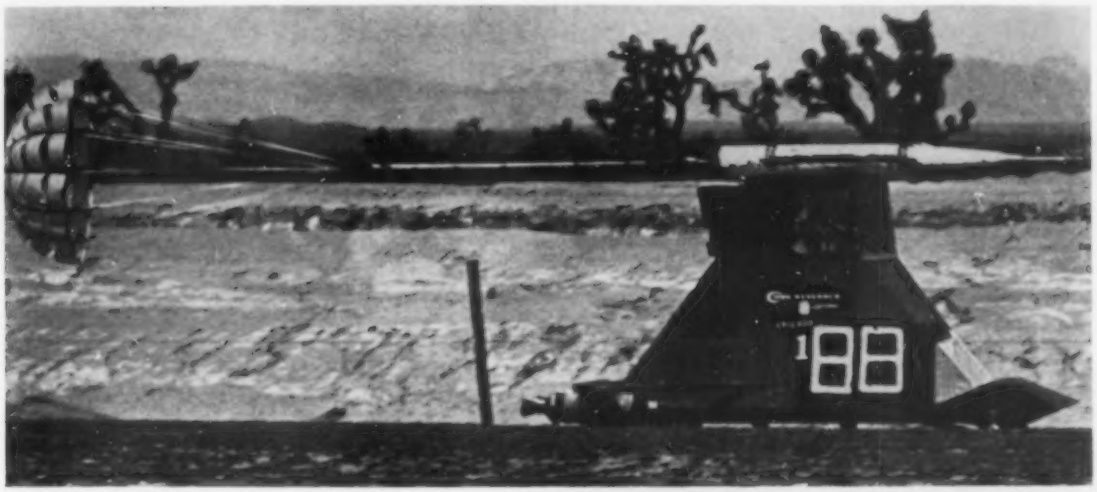


Fig. 1 **RING SLOT PARACHUTE** tested on a rocket sled. Disadvantages to this method are its high cost of operation and the sled's inability to maintain a steady state velocity. The time required for a complete test involving 7 or 8 speeds is much longer than the water test which requires less than 8 hours.

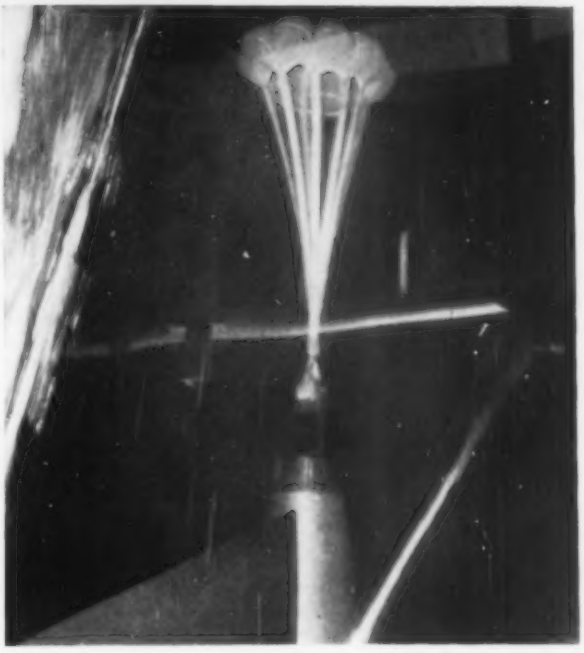


Fig. 2 **HIGH SPEED CARRIAGE** in David Taylor Model Basin pulling a 2 ft dia guide surface parachute. The towing carriage was travelling at 20 knots at the time. Wake is from strut at left, while crossbars and supports shown are reflection of bracket supporting the strut shown in Fig. 3.

Supersonic Parachutes Get Underwater Tests

If the results of tests now going on at the Navy's David Taylor Model Basin prove conclusive, future parachute designs might be tested underwater at low speeds, Fig. 2, to determine their opening, drag, and stability characteristics at supersonic speeds. The tests, sponsored by the Wright Air Development Center, Air Research and Development Command, will be compared with tests presently being made on parachutes using high speed rocket sleds, Fig. 1. Because of the higher density of water, the pressure associated with the speed is about 800 times greater than the pressure in air at the same speed. Or, 46 knots in the water roughly equals 1500 mph in air at sea level.

This unorthodox method of testing was conceived primarily to check the strength of parachutes, for with the increased operating speeds of aircraft and missiles, the problem of developing parachutes for such applications (human and non-human) has become more difficult. Supersonic wind tunnels, which could be used for such tests, are not available to handle parachutes of any great size. And, tests using the rocket sled have the disadvantage that the parachute is exposed to the maximum pressure for only a

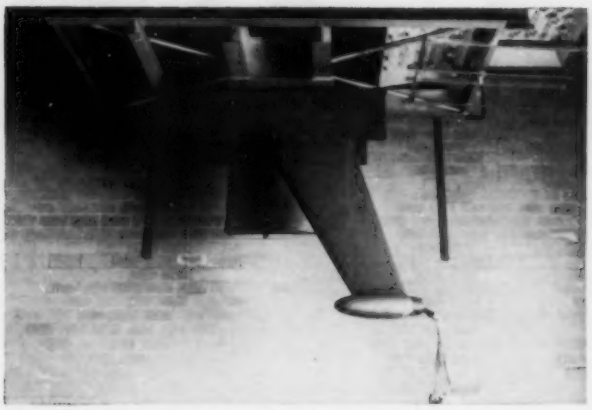


Fig. 3 GENERAL ARRANGEMENT OF parachute towing strut with test parachute and the strain gage type dynamometer hanging from the housing. The output of the strain gages, fed to an oscillograph, gives information on opening time, resultant, side, and vertical forces. Bank of lights on carriage, upper right, serves as a light source for high speed motion picture cameras above water.

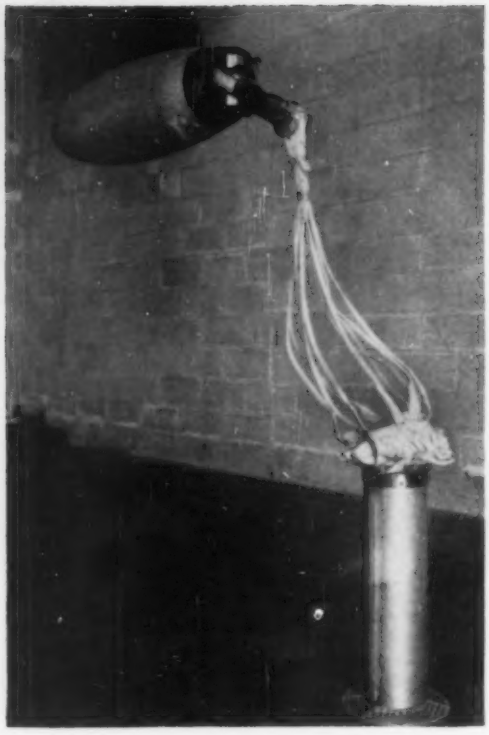


Fig. 4 THE CONTAINER for the parachute and dynamometer fits inside housing at the bottom of the strut, Fig. 3. The drag device on the end will insure a quick release of the parachute and the container. The device is released remotely by an electromagnet. Early difficulties caused the holding device for the shroud lines to slip, tending to spill the parachute and reducing frontal area.

brief time, since the speed is rapidly decelerated by the parachute drag.

So far, the underwater tests have proved the following:

(1) Damage to the parachutes while they were towed through the water is of the same type as the damage which is experienced in the actual use of parachutes.

(2) The towing carriage at the Model Basin is capable of speeds up to 60 knots, and its controls will maintain constant drag speed, within one per cent. However, maximum speed was limited to that causing cavitation on the parachute. The parachute damage can be closely related to the pressure and time duration under which the damage occurred. With the rocket sled, a high steady state velocity is difficult to achieve, for the sled is constantly slowing down. To determine the other characteristics of the parachute, it is also necessary to separate the transient and steady state effects. Here the tests in water seem to be more advantageous.

(3) All test equipment travels with the carriage, and is seen by the operators, permitting correlation of observations with measured quantities.

(4) Disregarding the initial cost of the installations, the water tow tests in a certain velocity range are more economical and less complicated than the rocket sled system. Because of the method and the facilities at the Model Basin, a parachute can be tested in the water for all speeds (7 or 8) in less than 8 hours for approximately $300. With the rocket sled, one test at supersonic speed may cost 5 to 10 times as much. However, the rocket sled is able to withstand forces up to 10 times higher than the carriage at the Model Basin.

(5) One problem associated with the water tests is cavitation, which occurs on the parachute in the neighborhood of a speed of 30 knots. Beyond this speed, the results are not comparable to the results in air, since the flow pattern is radically changed. As the speed at which cavitation begins is determined by the absolute pressure, this speed could be increased by towing the parachutes in deeper water, or in a pressurized water tunnel. It has been estimated that to prevent cavitation below a stagnation pressure of 6000 psf (equivalent to an air speed of about 1550 mph at sea level), the parachute would have to be towed at a depth of 100 ft, or tested in a water tunnel at a pressure of about 3 atmospheres.

Other effects which must be taken into consideration are: the wake interference; the surface effect; and the sur-

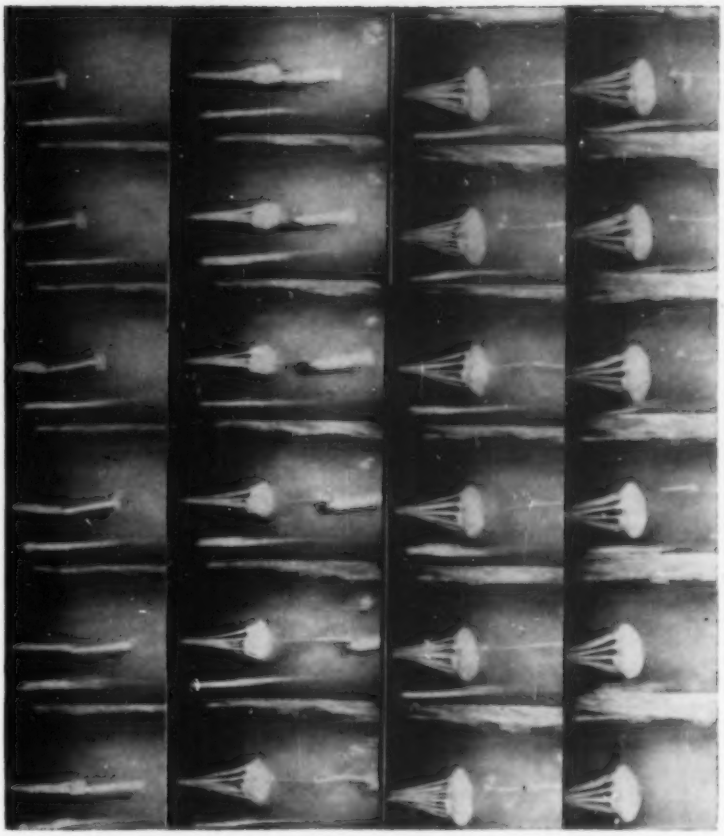
FULLY DEVELOPED CAVITATION on a 2 ft dia guide surface parachute pulled through the water at 46 knots. In tests, each parachute was inspected for damage after each run before repacking it for the next speed run.

face tension effect (the flow of the liquid through the fabric of the parachute); and the geometry of the basin, which is only 21 ft wide and 16 ft deep. The wall and bottom construction is noticeable in tests made on the 5 and 6 ft dia parachutes.

The rocket sled has effects such as the shape of the sled; and the parachute's proximity to the ground which must be taken into consideration.

Tests were made on three types of parachutes: guide surfaces; ring slot; and solid flat with diameters of 2, 2.4, 5 and 6 ft. Test speeds ranged from 8.5 to 46.6 knots. The speeds were selected to cover a range of stagnation pressures up to 6000 psf, or until the maximum towing load of the carriage was reached (18,000 lb).

Results of tests made at the David Taylor Model Basin are being correlated with rocket sled tests to see if the action of a parachute in the air can be based on tests made in water. So far, the reports are good. Cavitation begins at around 30 knots (a stagnation pressure of 3000 psf when towing the parachute at a depth of 8 ft from center), and beyond that point all correction factors must be discounted. However, if the drag coefficient does not change up to this speed, and is independent of the Reynolds Number, then speeds beyond 25 knots can be extrapolated. A straight line has been established.



AN OPENING SEQUENCE in water of a 2 ft dia guide surface parachute at 19.5 knots. Stagnation pressure is 1000 psf, or about 625 mph. The approximate elapsed time was 0.4 second. Other parachutes of 2, 2.4, 5, and 6 ft dia were tested at speeds ranging from 8.5 to 46.6 knots.

Simplified Automatic Navigator

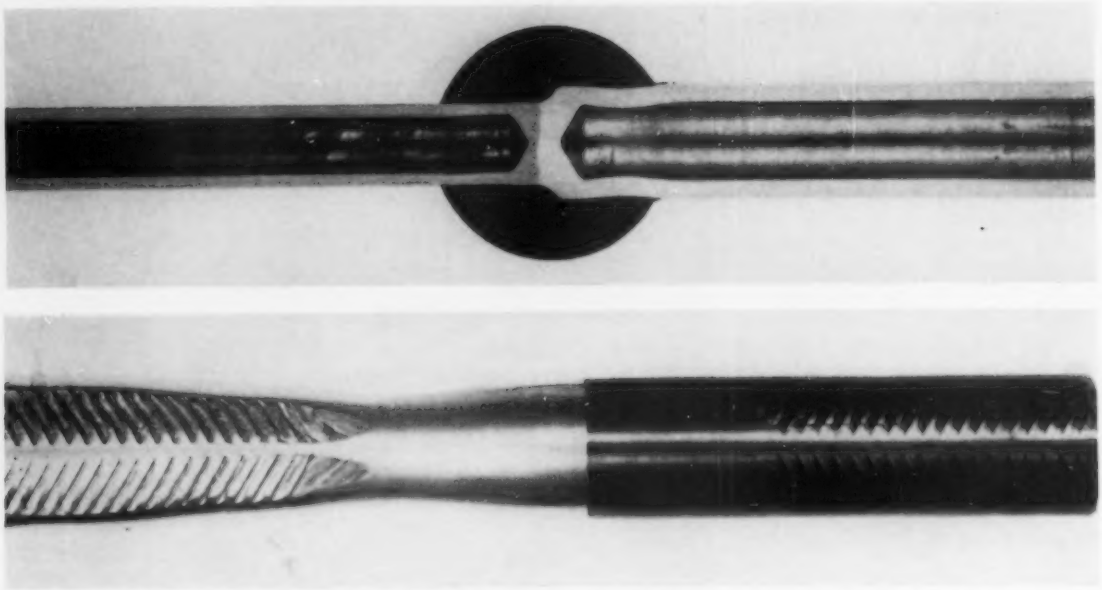
Aerial navigation has been simplified by a new device that operates automatically any place in the world, and does not require any outside aids, such as ground-based stations or celestial fixes. The device, called the AN/APN-66, was developed by General Precision Lab., Inc., of Pleasantville, N. Y. for the Weapons Guidance Lab., of the Wright Air Development Center.

Using a new concept in air navigation called the Doppler effect, the system directly measures ground speed and drift angle, navigates in any weather, including zero visibility, and will accomodate very high speeds and altitudes. The latter is of importance, since the delay in computation using optical or radar fixes often makes the information obsolete. Furthermore, optical ground fixes are impossible in bad weather and limited at night, while search radar fixes are not available over open water.

The basic principle of the Doppler effect is that if an aircraft in motion transmits electromagnetic pulses to the ground, the return pulses will be slightly shifted in frequency. From this Doppler shift of pulses, the aircraft ground speed and drift angle are determined by the AN/APN-66. This information is continuously combined with compass heading to provide an instantaneous indication of aircraft position.

The automatic navigator also displays all other information needed for navigation such as ground speed, drift angle, wind speed and direction, shortest course to destination, steering signal and others. The system will compute and indicate accurate data even if the Doppler pulse contact with the ground is interrupted.

The equipment will be particularly useful in polar flights, because rapid magnetic variation changes make air navigation difficult. The close proximity of the aircraft to the magnetic pole makes it impossible to use it for a reference point. The AN/APN-66 automatically switches to "transverse operation," i.e., the establishment of a new "pole" on the equator near the 180 deg meridian. This equipment should permit the reduction of the normal complement of three navigators for polar flying to one.



AT TOP IS A LONGITUDINAL CROSS SECTION of an AlCUnector suitable for connecting No. 4/0 AWG ACSR and No. 2/0 copper conductor, and hermetically sealed in a rubber ball and cement system. Bottom is a connector with a 1.25 in. dia pressure weld which has been subjected to a tensile load of 15,000 lb.

Hermetically Sealed Aluminum-Copper Connector

Two principal problems experienced with the joining of two dissimilar metals—galvanic corrosion and thermoelastic ratcheting—have been solved with the development of a connector for joining aluminum to copper electrical conductors under severe weather conditions.

Called the ALCUnector, and developed by the Kaiser Aluminum & Chemical Corp., Oakland 12, Calif., the connector in one form consists of a deep aluminum and copper cup butt welded together at the closed ends and hermetically sealed in a rubber ball and cement system.

Normally, the conductors are attached by the compression barrel method, but a combination of compression barrel and split bolt connector has also proved satisfactory. A number of the connectors have been produced in open tip and in large size conductor-to-terminal designs. Connectors of the straight-through compression type have been produced experimentally in sizes to accommodate aluminum conductors from No. 4 to No. 4/0 AWG, and copper conductors from No. 6 to No. 2/0 AWG. Flash or pressure butt-welding produced strong aluminum-to-copper, greater than the ultimate tensile strength of the aluminum, and did not add any electrical resistance to the joined sections.

The Nos. 4 and 6 AWG connectors, which are intended to carry 135 amp full load, were stable following tests of 500 amp cycles, applied 20 sec in each cycle. Internal resistance measured at points ¾ in. to either side of the weld averaged 22 microohms initially, and was unchanged through ten high current cycles.

New System for Linear Position Control

Measurement of linear displacements to accuracies of 0.0001 in. over distances of several feet is possible with a new type of transducer developed by Canadian Westinghouse Ltd., Hamilton, Ontario. The device can be applied to lathes, boring mills, jig borers and all types of special machines in which cutting tools must be positioned with great accuracy.

The transducer consists of two electromagnetically coupled parts. The primary part is a long cylindrical bar of solid insulating material, or a bar coated with insulating material. In this bar, two grooves are cut in the form of a two-start spiral. Wound in these grooves are wires which are joined at one end of the bar and connected to slip rings at the other, forming a long bifilar coil. The secondary part of the transducer, similar to the primary part, is also a bifilar coil, but is wound on the inside of a sleeve which can slide over the primary position of the transducer.

When the wires of the primary and secondary coil are aligned, a maximum electromagnetic coupling is attained. On each turn of the secondary coil, voltages now induced by currents in the two adjacent wires in the primary

coil are equal and of opposite polarity, thus cancelling each other. Zero output voltage is thus obtained on the secondary coil. When the position of the transducer secondary is changed from a position where the wires of the primary and secondary coil are aligned to a point where the wires of the secondary coil are between those of the primary, the output voltage passes through a null and again rises until a new maximum is reached. This occurs when the wires of primary and secondary are realigned.

In this aligned position, however, the output voltage is in opposite phase since the wires of the secondary coil are now aligned with primary wires in which current flows in the opposite direction. Thus, the output voltage of the transducer is approximately a sinusoidal function of the relative position between the primary and secondary coil. The period of this sine wave is equal to the lead of the transducer coils.

Westinghouse claims that accurate positioning systems may be built with this transducer. Continuous fine adjustment over its full range makes it suitable for precision programming, with the main feature being a link between the computer and machine. Besides numerical control from a set of dials for each coordinate, correlated control through tape or punch cards will permit several coordinates to be controlled simultaneously.

Solid Electrolyte Lengthens Capacitor Life

Problems of leakage and evaporation of the liquid electrolyte in electrolytic capacitors have been overcome with the development by the Bell Telephone Lab., West St., New York 14, N. Y., of a solid electrolyte—a semiconducting oxide. Free of aging, which sometimes necessitates periodic preventive replacement of conventional capacitors, the new solid state capacitors also have a better space factor.

Semiconducting magnanese dioxide replaces the liquid in conventional electrolytic capacitors. The anode may be any one of the film-forming metals, but tantalum is preferred because of its good oxide film, its availability in porous sintered form with a large surface to volume ratio, and its resistance to corrosion which prevents shelf and service aging.

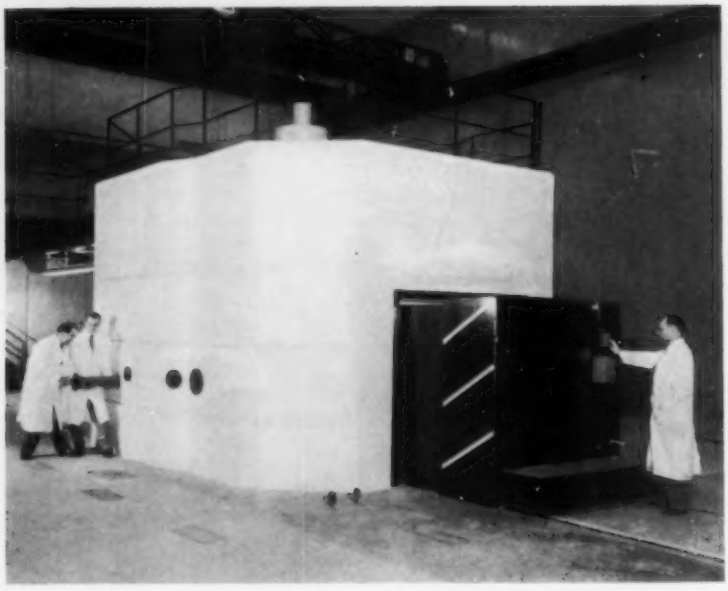
The oxide film on the anode is formed like that of the conventional electrolytic capacitors; and after removal of the liquid used in the "forming" of the successive layers of manganese dioxide, the carbon and lead alloy or copper are deposited. The result is a dry "solid state" capacitor with good stability with time and temperature because of a rectifying barrier of tantalum, tantalum oxide, and manganese dioxide.

Voltage ratings as high as 35 v can be obtained. To illustrate its small size, a 20 microfarad unit rated at 35 v occupies 0.04 cu in., equal to a capacitance of 500 microfarads per cu in. Based on the anode volume alone, the capacitance is 1500 microfarads per cu in.

The Back-Seat Pilot

In the cabin of this T-29 airliner (a military version of the Convair 240), the plane-within-a-plane tests a new advanced control system designed by the Hughes Aircraft Co. for a jet all-weather interceptor plane. The cockpit (right foreground), simulates that of an F-102. Once the T-29 is aloft, the regular pilot transfers control of the plane to a pilot in the cabin F-102 cockpit, who flies it as though he were in an interceptor, operating the "seek, find and kill" system. By spreading out the control system in a big cabin, several people can check the operation of its components simultaneously. In addition, a psychologist checks the cockpit's instrument arrangements, colors and lighting, and observes the pilot's reactions. Often, the thirteenth man on board for such a flight is a second pilot for the F-102 cockpit, so that different human reactions can be studied under similar conditions.

The advantage of such a setup is that many adjustments can be made in series on one flight to observe the effect while the conditions are the same. In an interceptor, it would mean one flight per modification evaluation. A financial saving is possible. The T-29 can be flown and maintained at one-fifth the cost of a jet plane.



First Private Nuclear Reactor For Industrial Research

The first nuclear research reactor designed particularly for peace-time use by private industry went into operation recently at Armour Research Foundation of Illinois Institute of Technology. Designed and built by Atomics International, a division of North American Aviation, Inc., this reactor opens up new fields in industrial research by providing a source of neutrons and high-energy gamma rays, and by making readily available a supply of useful isotopes. The installation located in South Chicago will enable industry for the first time to conduct reactor studies without security restrictions and military competition.

The $700,000 reactor was designed as a cooperative venture with 24 industrial companies each contributing $20,000 toward the construction and initial operation. Armour Research is providing the remaining funds. In return, the companies will share in the benefits of an extensive three-year program whose aim is the application of atomic techniques to industrial problems. Other features of the participator plan include detailed technical advice, certain patent benefits, and limited specialized training.

The reactor is of the "water boiler" type and is capable of operating at a power level of 50,000 watts. It will yield a maximum thermal neutron flux of approximately 2×10^{13} neutrons per sq centimeter per sec. The reactor employs one kilogram of U-235, obtained from the Atomic Energy Commission on "extended loan," as required by law. The reactor is equipped with a number of ports for easy accessibility. In addition, it has a five foor square thermal column for the production of a rather pure thermal neutron flux. A large source of gamma radiation is available from the components of the fission products which accumulate in the reactor's plumbing system. This system is placed in an isolated room below the reactor and is surrounded by access ports for gamma irradiation. Estimated strength of this gamma source is 50,000 curies, giving a flux of 1 to 10 million roentgens per hour.

Probably the most frequent use of the reactor will be in the production of short-lived radioisotopes which are used in tracer techniques. The gamma ray facility will prove helpful in radiation sterilization studies, effects of gamma radiation on solids, its effect on chemical reactions, and many other areas. Neutron diffraction supplies the possibility of obtaining structure analysis for light elements in the presence of heavy elements. The effects of radiation in biological systems will also be studied.

The reactor room is part of a new building which will house the Physics and Electrical Engineering groups in the Foundation. The entire five-story structure is air conditioned, with special provisions provided for a negative pressure in the radiochemical area and a still slightly greater negative pressure in the reactor room itself. A feature of the reactor is its self-contained design which confines all radioactivity within a triple containment system.

U. S. Companies to Study European Ideas

To keep industry in this country up to date on European technical development, the Armour Research Foundation of the Illinois Institute of Technology, Chicago 16, Ill., has set up a program known as the European Technological Observation Group Plan. Eighteen companies are taking part in the plan, and the service is being offered by the Foundation to noncompeting firms interested in ideas and techniques of potential value in the American market. Headquarters will be in The Hague, Netherlands.

A staff of five engineers will serve as observers in the fields of mechanical, electrical, and chemical engineering, metallurgy and chemical production, and each observer will be assigned prime responsibility for the four sponsoring companies in his field of engineering.

Participating companies permitting the use of their names are: Mechanical Engineering: Caterpillar Tractor Co.; Power Regulator Co.; Aro Equipment Corp. Chemical: Parke, Davis and Co.; Quaker Oats Co. Chemical Engineering: American Hard Rubber Co.; International Minerals and Chemical Corp.; Mosinee Paper Mills Co. Electrical Engineering: Amphenol Electronics Corp.; Louis Allis Co.; Warwick Mfg. Corp.; and Texas Instruments, Inc.

Armour stressed the fact that the observers will not engage in surreptitious activity, but will transmit only freely available information.

BRIEFS

A new agency, a nonprofit corporation, has just been established by the Dept. of Defense for research on military problems. The agency will conduct scientific analyses of present and future weapons systems for the Weapons Systems Evaluation Group, which was established by the Dept. of Defense in 1949. Members of the new agency are: Massachusetts Institute of Tech.; California Institute of Tech.; Case Institute of Tech.; Stanford University; and Tulane University. Dr. James R. Killian, Jr., Pres. of MIT, has been elected chairman of the board of trustees.

Government supported engineering research in American universities is 100 times that in Britain, according to a report from the director of the Production Engineering Research Association of Great Britain. Estimated total expenditure for research in the U. S. last year, including the above universities figure, was about $5-billion, compared with about $700-million in Great Britain. Total number of people engaged in research in Great Britain is only 60,000 compared to about 500,000 in this country.

De-inking waste paper by a method that is said to be both economical and efficient might be the answer to the chronic newsprint shortage. In a process developed by a University of Texas chemist and a former graduate student, shredded paper is placed in water, and a detergent and salt are added to loosen and separate the ink from the cellulose. The mixture is then heated, and charged with an electric current to increase the separation of the ink particles from the cellulose. Finally, water is removed from the cellulose fibers which are then washed and bleached. The product is said to be equal in color, brightness and strength to the original pulp, and the price well below the cost of new paper. At present 78 per cent of the total amount of newsprint used in this country comes from Canada, with a 76 per cent increase in consumption predicted by 1980.

Four molybdenum-base alloys with greater structural strength at higher temperatures than existing commercial materials have been announced by Climax Molybdenum Company, Detroit, Michigan. The alloys now commercially available, and which can be fabricated on conventional equipment are: 0.3 per cent columbium-stabilized; 0.5 per cent titanium-stabilized; 1.0 per cent vanadium-stabilized; and 2.0 per cent tungsten-stabilized molybdenum. With a high strength above 1600 F, some suggested uses are: electrodes and auxiliary equipment for glass-melting furnaces, and piercing points used in the manufacture of seamless tubing.

A copper-zirconium alloy with high electrical conductivity and good strength-retention at elevated temperatures has been developed at Battelle Memorial Institute, Columbus, Ohio. Suggested use is for electric motor commutators operating at temperatures above 500 F. Electrical conductivity of the alloy is 95.8 per cent of that of the copper standard. Rate of loss of strength under load is said to be low by commutator alloy standards. Other properties of the alloy, now in production, are good machinability, ability to develop and maintain a commutator film, and strength increase without notching. Brush life with the alloy is reported to be at least equal to that with similar commutators made from silver-bearing copper and chromium-copper alloys.

The Department of Defense has abolished all restrictions on the use of tungsten in jet aircraft. A bill introduced by Senator James E. Murrary (D.), Montana, chairman of the Senate Committee on Interior and Insular Affairs, provides that 1,250,000 short ton units of tungsten trioxide may be purchased from domestic tungsten mines over a period ending December 31st, 1958. The bill further provides for the maintenance of production of tungsten, asbestos, fluorspar, and columbium-tantalum in the U. S. There is evidence that Russia inst. is using up to 50 per cent tungsten in its jet engine design.

The life of internal-combustion-engine valves may be extended from two to three times that of conventional valves by applying a protective aluminum-iron alloy layer to the working forces of the valve. Increased oxidation resistance results primarily from the aluminum and complex iron-aluminum oxides which produce a protective film 0.0005-0.001 in. thick. The process consists of degreasing, induction pre-heating to 400 F, aluminum spraying, induction post-heating to 1400 F to form the alloy film. Since the final induction heating affects the entire valve head, the high temperature causes a slight distortion. To counteract this Thompson Products, Inc., Valve Div., Cleveland, Ohio, developers of the process, suggest the use of radio-frequency heating in the last stage of the process. By this method, the outside periphery of the valve will be heated, and distortion will be kept to a minimum.

The problem of diffusion of boron carbide has been solved according to Brooks & Perkins, Inc., Detroit, Michigan. Heretofore, the manufacture of "Boral," a neutron shielding material used by atomic energy installations, had been impeded by the problem of even dispersal of boron carbide throughout its aluminum shell. Boral consists of a core of boron carbide uniformly dispersed and clad on both sides with commercially pure aluminum. The grade now being offered by Brooks & Perkins is a 35 per cent concentration of boron carbide. Alcoa has also announced the commercial availability of boral. Alcoa's boral plate and sheet is available in two standard tempers, annealed and fabricated, and in standard sizes of 48 x 120 in. and 36 x 96 in. Thicknesses available are ¼ and ⅛ in.

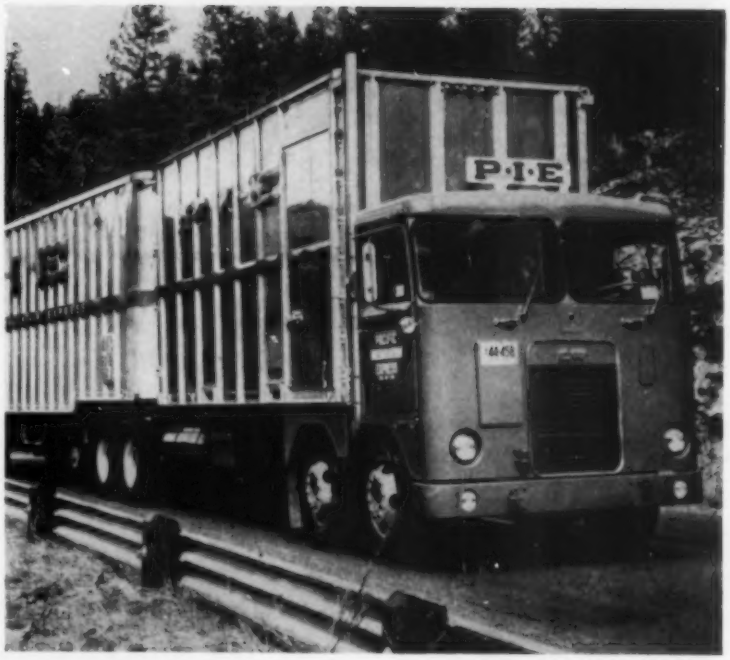
The sale of many enriched stable isotopes, as well as the loan of rare and expensive isotopes is now possible through a revised distribution policy as set forth by the Atomic Energy Commission. Under certain conditions some foreign nations are now permitted the loan of these items. Moreover, neither domestic nor foreign applicants will be required to file and obtain A.E.C. approval before purchasing these materials. Complete details of the sales and loan policy may be obtained from the Stable Isotopes Div., Oak Ridge National Lab., Union Carbide Nuclear Co., Oak Ridge, Tennessee.

THE NEWS IN PICTURES

NEW RADIAL DRAW FORMING TECHNIQUES developed by The Cyril Bath Co., 32354 Aurora Road, Solon, Ohio, now permit the forming, in one operation, of parts either tapering from end to end or varying in cross sectional area throughout the piece. The new techniques use the Bath radial draw form machine with a traverse compression unit. In one method, the radial draw former stretch-forms the lighter cross sectional area of the material, while the hydraulic ram of the transverse compression unit exerts pressure at the point of tangency of the material and the contour die, and progressively increases the pressure to form the heavier cross sectional areas. For forming tapered sheets of more complex contours, the Cyril Bath Co. has designed pressure shoes consisting of a flexible wipeface, backed up by a series of shoe segments, each hydraulically powered and so connected as to flex the wipeface to any desired contour Both techniques may be used to form sheets, extrusions or other sections

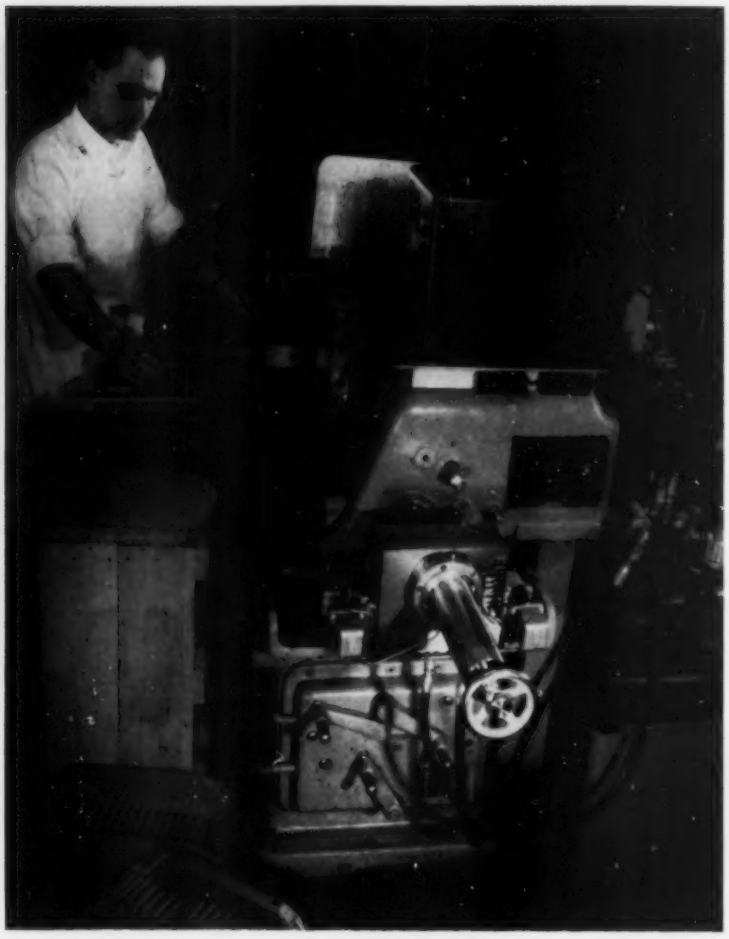
A PILL IN THIS AUTOMATIC INFLATOR will cause the conventional "Mae West" life jacket to be inated within 15 sec. after it is immersed in water. The automatic inflator is shown fastened to the standard CO_2 inflation device found on all such life jackets. Weighing 5 oz., the inflator consists of a cap, a piston, a spring-loaded plunger, a soft rubber flapper valve, and an effervescent pill of 60 per cent tartaric acid and 40 per cent sodium bicarbonate that is about the size of an Alka Seltzer tablet. When submerged, water passes through an opening in one end of the metal cap, forcing open the rubber flutter valve. The water passes through the valve and hits the surface of the tablet, causing it to dissolve and produce a cloud of gas. The gas pushes the flutter valve back into place at one end of the chamber and forces down the piston at the other end. This releases the spring-loaded plunger, which hits the manual operating lever to fire the CO_2 cartridge which inflates the jacket. Because of a flutter valve, the device cannot be set off by rainfall, heavy dew, or accumulated moisture. North American Aviation, Los Angeles, Cal., is the designer.

BOTH FRONT AXLES steer on the latest type dromedary truck to be developed and put into service by the Pacific Intermountain Express. Manufactured by the Kenworth Motor Truck Co., Seattle, Wash. The truck also has front and rear air suspension; center mounting of a horizontal 250 hp Cummins turb-supercharged diesel engine; high visibility windshield; and extensive use of aluminum to reduce weight. The steering effort of the tandem front axles is said to be comparable to that of a standard 3-axle truck. The air bags over each set of axles fill with air as the load increases to maintain constant frame height. When equipped with a 17 ft. dromedary box (which can be lifted on and off the truck fully loaded) and a 35 ft. semi-trailer, the trucks will measure 60 ft. in length. Chassis weight is 15,770 pounds.



MORE POWERFUL PERMANENT MAGNETS will be possible, predicted Westinghouse Electric Corp., as a result of a new magnetic material that is practically 100 per cent pure manganese bismuth. Catching fire spontaneously on exposure to air (above), the finely ground powder must be prepared and processed in an inert atmosphere of helium gas. The feature of MnBi magnet is its great resistance to demagnetization. According to Westinghouse, the magnets are at least 10 times better in this respect than most commercial magnets presently available. The powder is preared by grinding the manganese and the bismuth together in an atmosphere of helium gas. The mixture is sealed in a glass vessel under low-pressure helium. The two metals are united chemically at about 520 F, the melting point of bismuth. This is reground to a fine powder, imbedded in a plastic matrix, oriented in a powerful magnetic field, and molded or extruded to shape. The magnets can be easily drilled, tapped, or even cut with a knife if the binder so permits. Also, because the plastic binder is an insulator, the MnBi magnets are nonconductors of electricity.

TECHNICAL NEWS



Millionth of an Inch Feed for Machine Tools

Accurately controllable in the micro-inch range, this inchworm motor is finding application in the machine tool field, where it is replacing lead screws in centerless grinders. The motor, designed by the Airborne Instruments Lab., Inc., of Mineola, N. Y., operates because of the magnetostrictive effect, whereby the armature of the motor shrinks under the influence of an electro-magnetic field, and snaps back to its original size when the magnetic field is de-energized. A pair of clamps working with the armature convert the expansion and contraction movements into forward or backward motion, and reverse on demand without backlash.

The inchworm motor is actually a linear actuator which produces a controlled increment of relative motion between its two moving parts. To get this motion between two bodies, each one is connected to one of the inchworm parts. Either part can be stationary depending upon the particular application. A rigid connection between the members is accomplished because there are no lead screws, split nuts, or bearings in the path of the transmitted force. Also, since no lead screw is used, there is an improvement in the system spring constant because the torsional strain factor usually introduced by the lead screw member is eliminated. Machine tools with heavy members sliding on the ways are said to have consistently repeated to an accuracy of ±5-millionths of an inch under machine load conditions, requiring a break-loose force of 300 lb and a sliding force of about 220 lb.

Second Titanium Conference at NYU

New York University's College of Engineering will hold its second annual titanium lecture from September 10th through the 14th. Conducted by the University's College of Engineering, the program was designed especially for practicing engineers, and titanium authorities from industry and research laboratories, plus members of NYU's faculty, will present 25 lectures. The subjects to be covered are: Extraction and Melting; Phase diagram metallography and alloying; Heat treatment and mechanical properties; Mechanical metallurgy and applications; and Fabrication.

Evening sessions will supplement the lectures, which will be given at the University Heights campus in the Bronx. Dormitory space on the campus will be available to those attending from September 9th to 15th. Attendance is limited. Applicants may register until August 15th.

SAE Will Publish New Drafting Manual

At its meeting in Atlantic City the Society of Automotive Engineers announced that it will publish a drafting manual combining the best and most widely accepted drafting practices in the aeronautic and automotive industries. Some of the projects on the agenda are:

1. Improvement of geometric and positional tolerance standards.
2. Simplification of drafting practices.
3. Investigation of the trend to eliminate specifying how to process a product on engineering drawings, in order to allow the maximum flexibility in the use of methods and equipment during manufacture.
4. Encourage the use of decimal dimensioning.
5. Standardizing the method of specifying screw threads.
6. Development of new drafting techniques for use in preparing drawings that are intended to be reduced in size.
7. Development of a standard method to specify on engineering drawings how to control variations in the shape of sheet metal parts.

COMING EVENTS

AUGUST 20-21

1956 National Telemetering Conference, Biltmore Hotel, Los Angeles, Calif. An average of four papers will be presented at each of the eight sessions: Systems I; Data Processing; Components and Equipment; Crowding of the Telemetering Frequency Bands; Systems II; Recorders; Components and Equipment II; and Telemetering Flight Testing of Piloted Aircraft. The conference is sponsored by AIEE, IAS, IRE and ISA.

AUGUST 21-24

Western Electronic Show and Convention (Wescon), Pan Pacific Auditorium, Los Angeles, Calif. Sponsored by the West Coast Electronic Mfrs. Association, and the Los Angeles and San Francisco Sections of IRE. Over 700 exhibitors will be in the auditorium and other tent facilities. The number of technical sessions has been increased over last year. To be held prior to the opening day of Wescon will be a meeting of the National Telemetering Conference scheduled for the 20th and 21st. Technical sessions will be held covering new developments in that field.

AUGUST 27-29

Association for Computing Machinery, University of California, Westwood Campus, Los Angeles, Calif. For information write: G. W. King, Box 3251, Olympic Station, Beverly Hills, Calif.

SEPTEMBER 10-12

Fall Meeting, ASME, Cosmopolitan Hotel, Denver, Colo.

SEPTEMBER 10-15

Investment Casting Institute, University of Michigan, Ann Arbor, Mich. A six-day course in investment casting will provide members of the Institute with the latest technical data. Much of the information was developed through ICI technical committees. Because of the laboratory experiments which are to be part of the course, registrations are limited to no more than 40 persons from the Institute's member companies.

SEPTEMBER 17-21

Second Pacific Area National Meeting and Apparatus Exhibit, of American Society for Testing Materials, Hotel Statler, Los Angeles, Calif. More than 200 technical papers and 43 separate sessions will be featured at this meeting on the properties and evaluation of materials. Plant and laboratory inspection trips, as well as exhibits of research and testing apparatus will be part of the program.

11th Annual Instrument-Automation Conference and Exhibit, New York Coliseum, New York City. Clinics, workshops and technical sessions will be conducted throughout the week program. Information on exhibit space can be obtained from Fred J. Tabery, Exhibit Mgr., 250 West 57th St., New York City, and on the educational program from the Instrument Society's national office, 1319 Allegheny Ave., Pittsburgh, Pa.

SEPTEMBER 24-28

1956 Trade Fair of the Atomic Industry, Navy Pier, Chicago, Ill. Sponsor of the Fair is the Atomic Industrial Forum, and the Fair is being held in conjunction with the Forum's annual conference on "management and technology for the atomic industry." On view will be a wide range of products and services related to the atomic industry; its major components, auxiliary equipment, and many accessories. For further information write to the: Trade Fair Dept., Atomic Industrial Forum, 260 Madison Ave., New York 16, N. Y.

SEPTEMBER 25-28

1956 Iron and Steel Exposition and Convention, Cleveland Public Auditorium, Cleveland, Ohio. More than 200 companies will have extensive exhibits and demonstrations. During the 14 technical sessions, upwards of 40 papers will be presented by members of the iron, steel and allied industries.

OCTOBER 1-3

12th Annual National Electronics Conference, Hotel Sherman, Chicago, Ill. More than 100 technical papers and 235 commercial exhibits will be featured on electronic research, development and application.

OCTOBER 3-5

Fifth Annual Meeting of the Standards Engineers Society, Hotel Willard, Washington, D.C. Theme will be "Standards–Guides for Tomorrow." Sessions are scheduled on standardization in the chemical industry, standards and the atomic energy field, future trends of standards in the metals field, creative engineering and standards, progress of engine standardization, and screw thread standardization from the viewpoint of the manufacturer.

OCTOBER 4-5

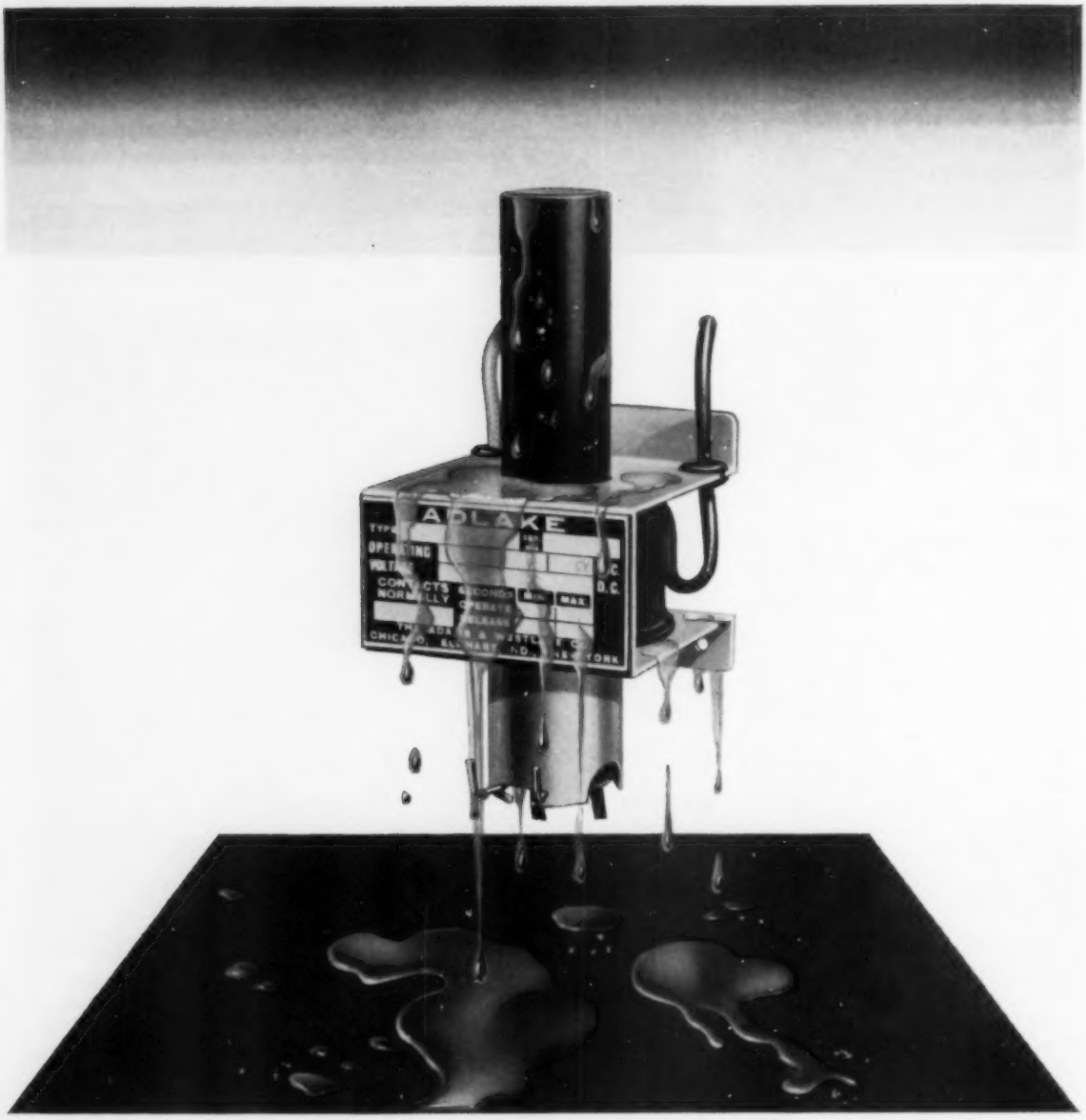
Annual Convention of the Magnesium Association, The Drake, Chicago, Ill. The meeting provides a platform from which current developments in magnesium use are presented and discussed by those using the metal in their production program.

OCTOBER 8-10

Annual Fall Meeting, Institute of Metals Div., Amer. Institute of Mining, Metallurgical and Petroleum Engineers, held in conjunction with the National Metal Congress and Exposition, Hotel Carter, Cleveland, Ohio. A nuclear metallurgy symposium on "Effects of Radiation in Metals" will bring forth papers on the theory and mechanics of radiation effects, irradiation effects in physical metallurgical reactions, and irradiation effects on reactor materials. A symposium on titanium as well as research seminars and summaries devoted to physical metallurgy are scheduled for the three days of the meeting.

OCTOBER 8-12

38th Annual National Metal Congress and Exposition, Cleveland Public Auditorium and Exhibition Hall, Cleveland, Ohio. Concurrent with the show, the National Metal Congress will hold scientific sessions in four headquarter hotels where some 150 technical papers will be presented. For the first time a presentation of formerly classified nuclear reactor components will be held.



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Radius of Curvature of Parabolic Cams

RUDOLPH GRUENBERG
Westinghouse Electric Corporation

FUNCTIONAL REQUIREMENTS generally fix the lift L and the corresponding cam angle β, while maximum size of the cam is dictated either by available space or by maximum pressure angle restrictions. But the cam must also be large enough—or the cam roller small enough—so that the least radius of curvature exceeds the roller radius. Unless this condition is observed, it may prove impossible to obtain the desired follower motion.

Therefore, having designed the cam for function, pressure angle and space limitations, the minimum radius of curvature will determine the maximum permissible roller diameter. Changing the roller diameter does not alter the pressure angle.

The following nomograph helps determine the least radius of curvature and maximum roller diameter. It can also be used to find R_M for given values of ρ, β, and L. To minimize "slapping," ρ_{min} should be at least 2 r.

Derivation

The nomogram is based on Eq (9) which, in turn, is derived from the general equation of a parabola, Eq (1), and the equation for the radius of curvature Eq (4). Derivation of Eq (9) is given below so that it may be modified to conform to other types of cam motion.

General equation of a parabola is

$$y = cx^2 \tag{1}$$

From which

$$dy/dx = 2cx \tag{2}$$

and

$$d^2y/dx^2 = 2c \tag{3}$$

Equation of radius of curvature is

$$\rho = \frac{[1 + (dy/dx)^2]^{3/2}}{d^2y/dx^2} \tag{4}$$

Inserting values from Eqs (2) and (3):

$$\rho = \frac{[1 + 4c^2x^2]^{3/2}}{2c} \tag{5}$$

Minimum value of ρ occurs at beginning of rise, therefore $x = 0$ and Eq (5) becomes

$$\rho_{min} = \frac{1}{2c} \tag{6}$$

From Fig. 1:

$$x = \frac{R_M \beta}{2}, \; y = \frac{L}{2} \tag{7}$$

where β is in radians. Combining Eqs (1), (6) and (7) gives:

$$\rho_{min} = \frac{R_M^2 \beta^2}{4L} \tag{8}$$

To convert β from rad to deg, Eq (8) is multiplied by the constant $(2\pi/360)^2$ to give:

$$\rho_{min} = \frac{R_M^2 \beta^2}{13100\, L} \tag{9}$$

(continued on page 221)

SYMBOLS

L = Lift, in.
R_O = Root Radius, in.
$R_M = R_O + \frac{1}{2} L$, in.
r = Rad. of cam roller, in.
ρ = Rad. of curvature cam surface, in.
β = Cam angle, deg

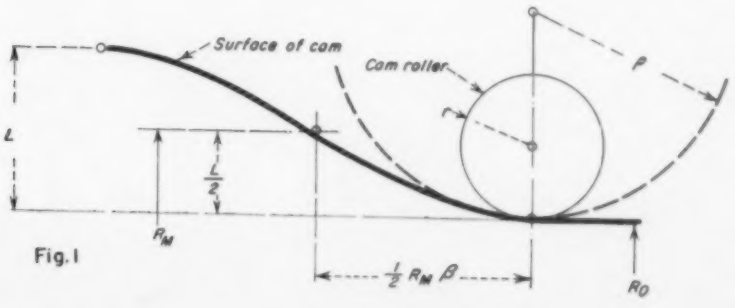
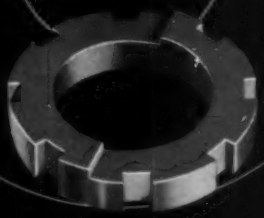


Fig. 1

Not 25 not 50 not 75 but 100%



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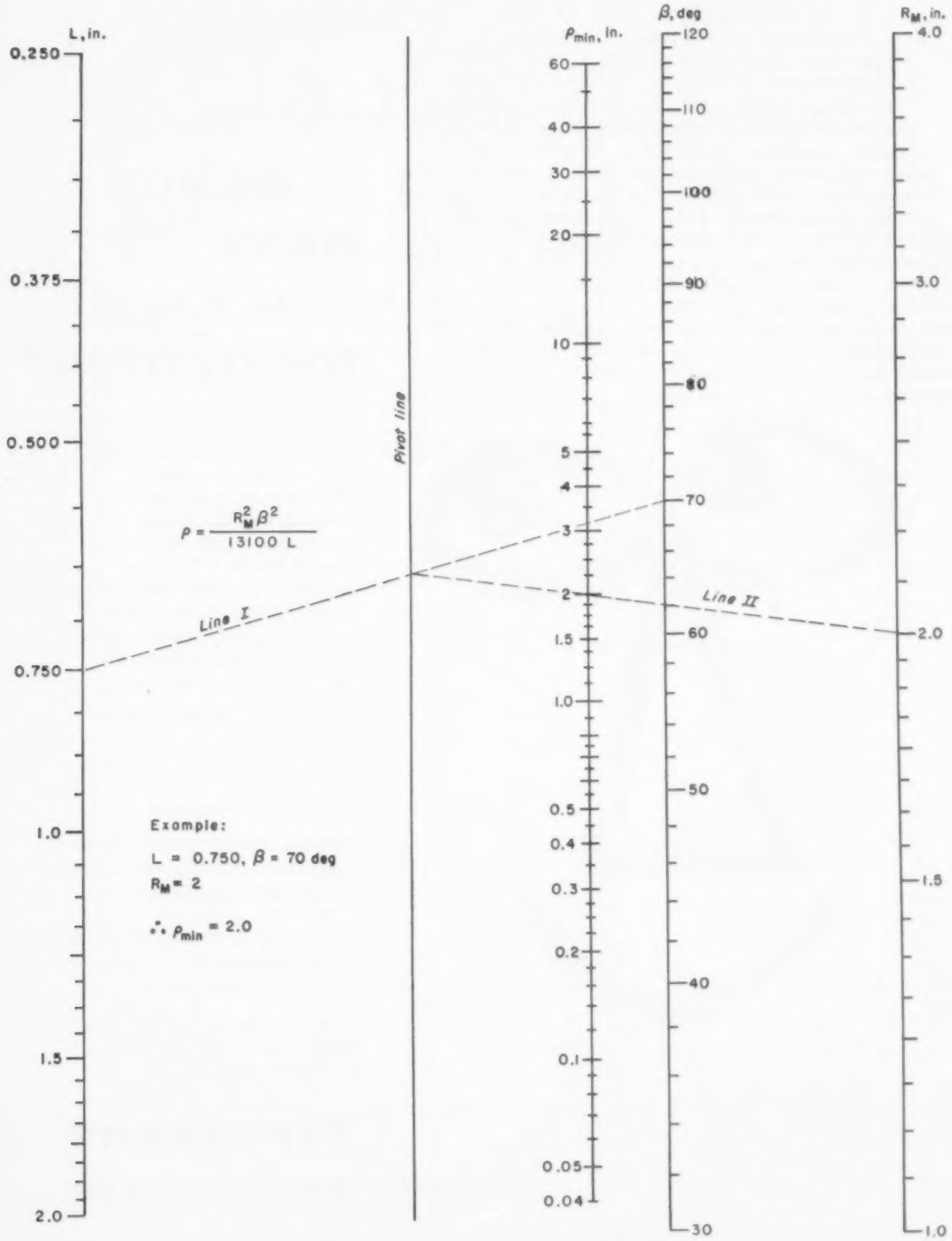
PRODUCT ENGINEERING - REFERENCE BOOK SHEET

Radius of Curvature of Parabolic Cams (continued from page 219)



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Simplified Graphical Integration

W. L. VAUGHAN
Project Engineer
Aircraft Research Div., The Budd Co.

A SIMPLE AND SURPRISINGLY ACCURATE METHOD for performing graphical integrations requires only the use of two triangles and a pencil. Principles involved are not new but seem to be little known. Accuracy of the method, if carefully followed, is equivalent to analytical integration performed with the aid of a slide rule. It has been used for calculation of bending moments and shears on airplane wings with an accuracy of 0.2 per cent. Time required is about one-fifth that of conventional tabular-step graphical integration. In fact, speed of the method in some cases raises doubts as to the economical feasibility of an electronic computer for integration problems.

The method is readily applied to the determination of shears, bending moments, slopes and deflections for non-uniformly loaded cantilever beams. For beams supported at two or more positions, simple corrections can be made based on the known boundary conditions such as the deflection or slope at the beam ends. Multiplication or division by constants, such as a safety factor, can be performed automatically during the integration.

Sample Constructions

EXAMPLE I—Given a non-uniformly distributed load on a cantilever beam shown in Fig. 1. Draw the shear diagram so as to include a 1.5 safety factor. Steps for graphical integration:

1. **Pick a convenient scale** for the shear curve so that the curve does not run off the paper. This can be quickly done by roughly estimating the area under the loading curve and multiplying by 1.5. Shear scale is shown at external left in Fig. 1; range is from zero to 600 lb.

2. **Establish a reference line** by dividing any value on

(continued on page 225)

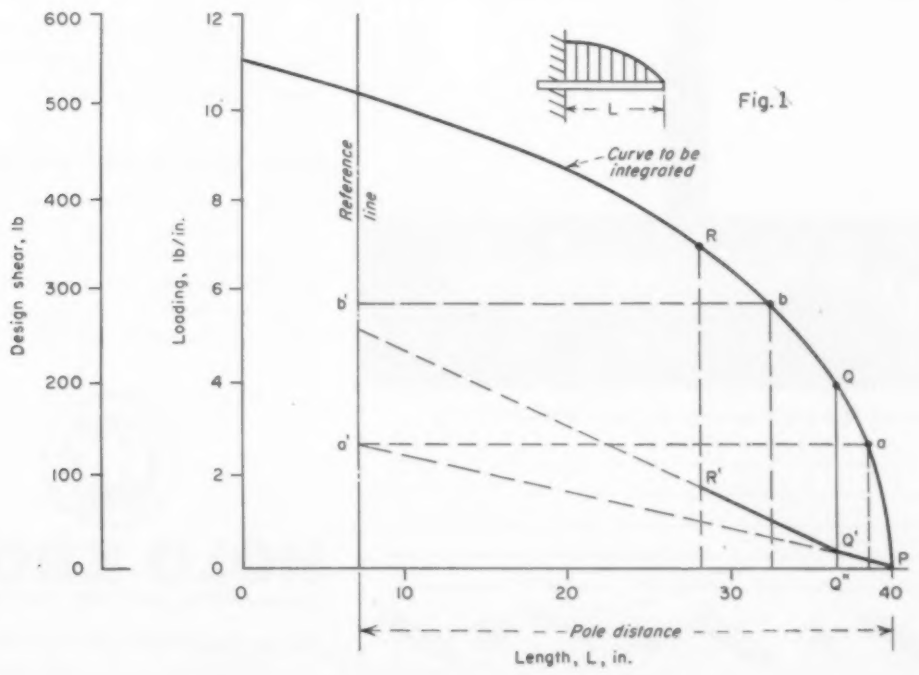

Fig. 1

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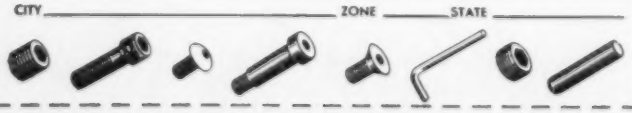

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Simplified Graphical Integration (continued from page 223)

the shear scale by the equivalent value on the load scale such as: 200/4 = 50. Divide this quotient by the safety factor to obtain a "pole distance" of 33.3 in. Pole distance is measured from point *P*, the starting point of integration.

3. **Take segments of the loading curve.** To integrate curve from *P* to *Q″*, project the midpoint of *Q″P* vertically to the curve to obtain point a, and horizontally to the reference line to obtain point a′.

4. **Draw straight line** from a′ to *P*. Ordinate at *Q′* represents the area under curve *QP* multiplied by the safety factor 1.5; line *Q′P* represents design shear curve from *Q′* to *P*.

5. **Use two triangles to obtain second point.** Repeat construction for second segment *RQ* to obtain *b′*. Connect points *b′P* with one triangle–with the aid of second triangle draw line *R′Q′* parallel to *b′P*.

6. **Repeat construction in step 5** to obtain the entire shear curve as a series of short straight lines. Lengths of segments may be varied as desired. Segment *PQ* does not have to equal *QR*.

EXAMPLE II–Given an overhanging beam simply supported at two points with single concentrated load at overhanging end as shown in Fig. 2. Find the slope and deflection by double graphical integration.

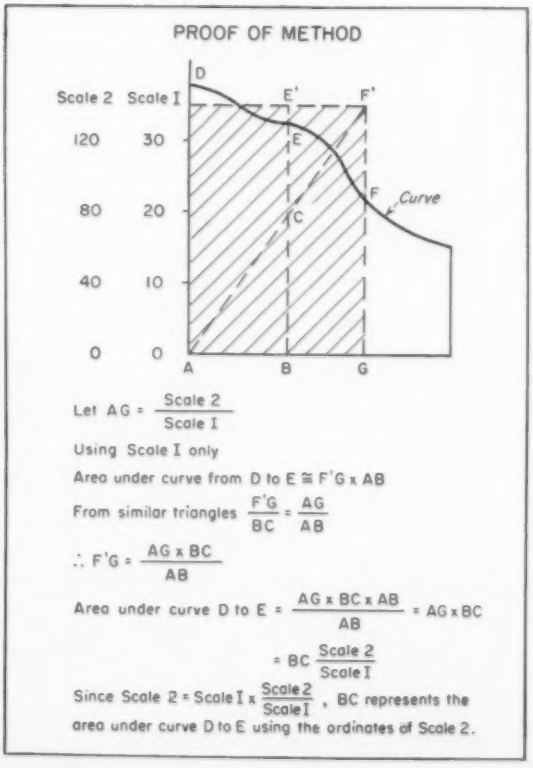
1. **Plot the M/EI diagram.** If *E* and *I* are constant, they can be included while integrating the moment curve.

2. **Integrate the M/EI diagram graphically** as was done in example I, assuming zero slope at R_1. This is an obvious error since the slope has some unknown value at this point. In making this assumption, the initial slope has actually been displaced vertically. Reaction R_2 is entirely ignored in this step.

3. **Integrate the slope curve** assuming zero deflection at R_1. This is a correct assumption since deflection at the support points is zero. Reaction R_2 is again ignored.

4. **Join points *A* and *B* with straight line.** Point *B* is intersection of the initial deflection curve and R_2. Since deflection is also zero at this point, a straight line connecting points *A* and *B* becomes the new base line from which true deflections may be measured perpendicular to the abscissa.

5. **Obtain true values in the slope diagram** by dividing the ordinate by the abscissa *(H/L)* of any point on the zero deflection line. This locates the zero slope line. True slope at any point of the beam is vertical distance between slope curve and zero slope line.


PROOF OF METHOD
Scale 2
Scale I
120
30
80
20
40
10
0
0
D
E'
F'
E
F
C
Curve
A
B
G
Let AG = Scale 2 / Scale I
Using Scale I only
Area under curve from D to E ≅ F'G x AB
From similar triangles F'G/BC = AG/AB
∴ F'G = AG x BC / AB
Area under curve D to E = AG x BC x AB / AB = AG x BC
= BC Scale 2 / Scale I
Since Scale 2 = Scale I x Scale 2 / Scale I , BC represents the area under curve D to E using the ordinates of Scale 2.

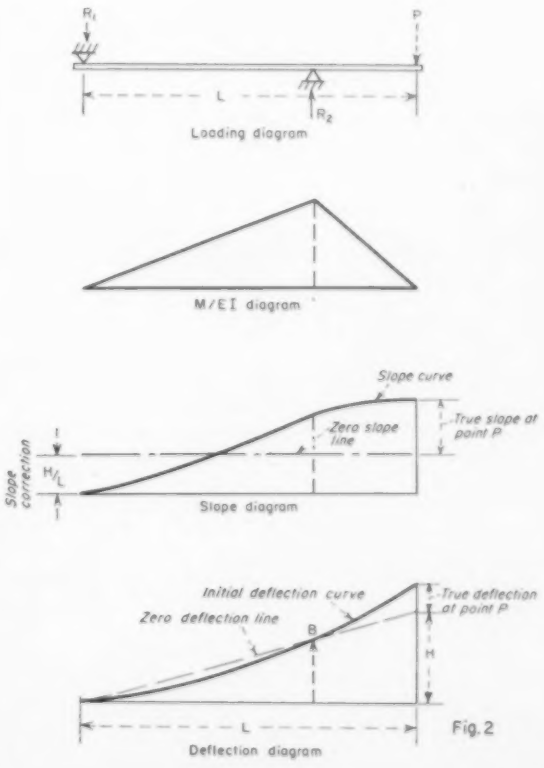
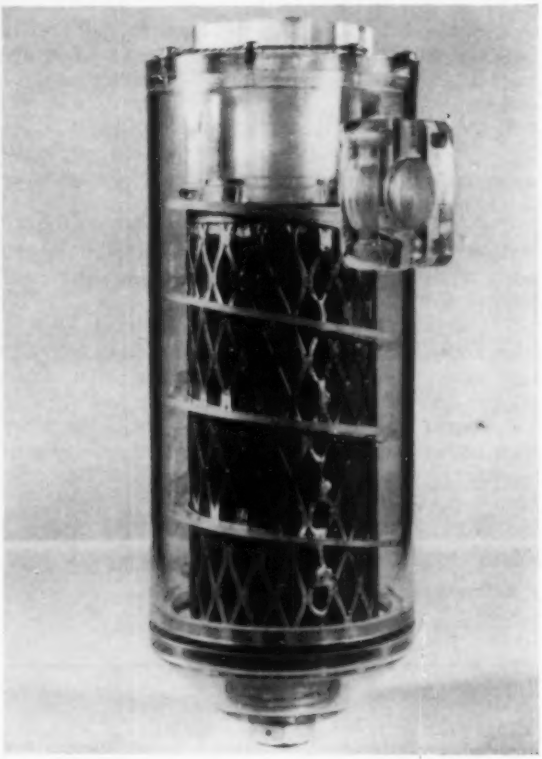


Fig. 2



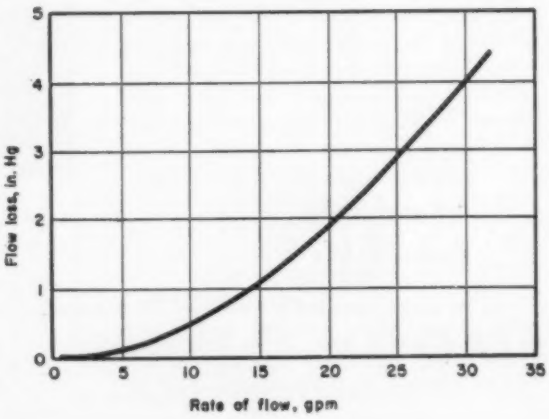
EXPANDED METAL SUPPORTS WIRE CLOTH retainer of filter's glass beads in this cutaway view. Helical vane guides fluid uniformly over entire filter area. Packed glass beads in combination with monel wire cloth provides depth filtration.

Precision High Flow Glass Bead Filter

A new glass bead filter permits an unusually high rate of liquid flow, screens out impurities as small as 40 micron and can be repeatedly cleaned. Developed originally for jet aircraft fuel systems, this industrial type filter is designed for coolant filtering for machine tools, chemical, petroleum and atomic processing, pharmaceutical manufacturing and distilling.

Packed glass beads or spheres are employed, in combination with a Monel wire cloth. Hardness, smooth surface and chemical inertness of the glass beads are said to increase filtering efficiency and minimizes clogging of particles filtered out of the fluid. Manufacturer claims better than 98 percent efficiency.

The filter offers protection against such fine contaminants as entrained water and atmospheric dust. It also resists the corrosive attack of the water in the system,



sulphur and salt atmosphere. In addition, it withstands up to 25 psi pressure, and serves over a temperature range of −65 F to 160 F.

The filter element is a round cannister enclosed by an expanded metal cylinder with glass beads packed around the periphery in an annular space approximately 0.125 in. wide between cylinders of wire cloth. The beads are 0.010 in. dia. The wire cloth has nominal openings 0.0041 in. square.

Rate of flow is high, but depends on the nature of the fluid. The filter will handle 27½ gal per min of jet aircraft fuel, for example, with a pressure drop of 2 psi. It allows flow at this maximum rate for 25 hr before cleaning is required. Backwashing is effective as a means of cleaning, and is reported not to cause loss of capacity even after hundreds of cleaning operations. Accumulated dirt can also be removed by a localized air blast.

Helical vanes in housing give input fluids a swirling action tending to keep large particles of dirt away from filter. Filtering action can be varied readily to meet differing requirements, since the degree of filtration is determined by the size of the glass beads and the mesh in the screen. The filter is now available in a broad range of sizes. The weight of the 1800-gph model is 8.1 lb. The unit can be made of aluminum, steel, stainless, rubber, glass, brass. Aero Supply Mfg. Co., Inc., Corry, Pa.

For more information—
Circle 1, inside back cover

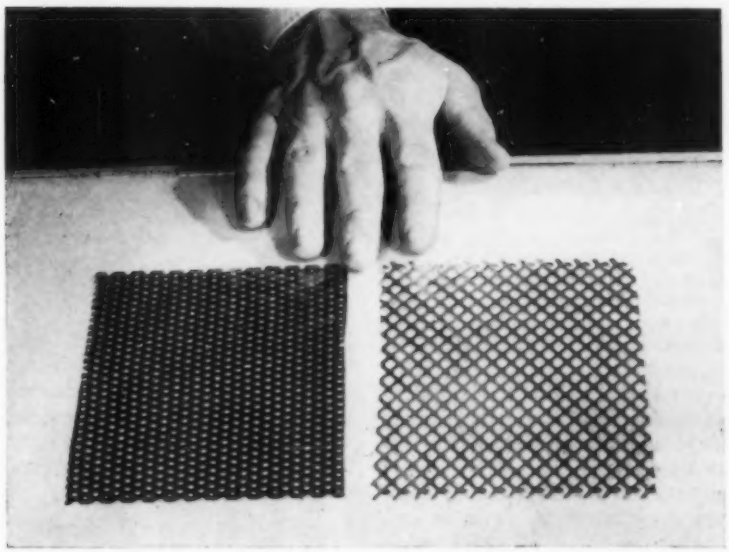
Silver Brazing Alloys in Expanded Strip Form

The principal advantages of this expanded strip brazing metal is said to be weight reduction of particular importance in assemblies for aviation service. As an example, an expanded strip may weigh less than one-third as much as solid strip of the same cross-section. To match the weight of 0.003 in.-thick expanded strip, a solid strip would have to be well under 0.001 in. thick—too fragile to handle conveniently.

The expanded silver alloy is produced by expanding conventional solid strip and then rolling the resulting grid down to the specified uniform thickness. The weight of the expanded strip is governed by the degree of expansion and final thickness after rolling. Expanded strips up to 12 in. wide in thickness or down to 0.003 in. can be supplied. Brazing alloys normally supplied by this manufacturer in strip form are available in the expanded form, as well as the other forms produced by the company.

The expanded strip will flow and wet the joint faces uniformly despite the interstices in the grid pattern. This is true not only for continuous joint faces, but also for honeycomb structures, so that maximum joint strength and uniform bonding will be obtained regardless of the alignment between the grid of the alloy and the edges of the honeycomb. The only requirement—no different from solid strip—is that the expanded strip be specified to contain a sufficient volume of filler metal to cover the joint area to the thickness normally required. Handy & Harmon, 82 Fulton St., New York 38, N. Y.

For more information—
Circle 2, inside back cover



Automatic Clutch Transmission

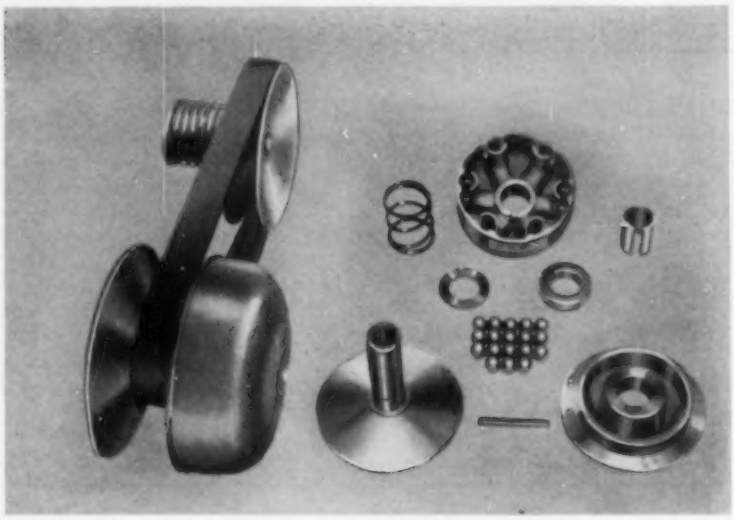
This transmission is composed of a centrifugal driver unit and a torque-actuated driven unit, which is said to transmit a balanced drive ratio under all operating conditions. By controlling centrifugal force, the flanges of both the driver and driven units are opened and closed as the engine is accelerated or decelerated. The driver unit has an idler bearing on which

CONTINUED ON PAGE 228

the drive belt runs free when motor is idling.

With acceleration, the flanges of the driver unit close while those of the torque-actuated driven unit open, giving a balanced drive between the two units. On vehicular equipment, no clutch or gear shifts are needed, the only operating controls being the throttle and brake. The driver unit has eight parts, the driven unit six. Both units are self-lubricating.

The transmission is available for up to 15 hp applications in standard sizes. The device is expected to prove adaptable to small motor vehicles, garden and riding tractors, conveyor apparatus, motor and power take-off drives or other applications subject to surge or peak loads. Miner Pulley & Transmission Co., 1201 E. 58 Ave., Denver 16, Colo.



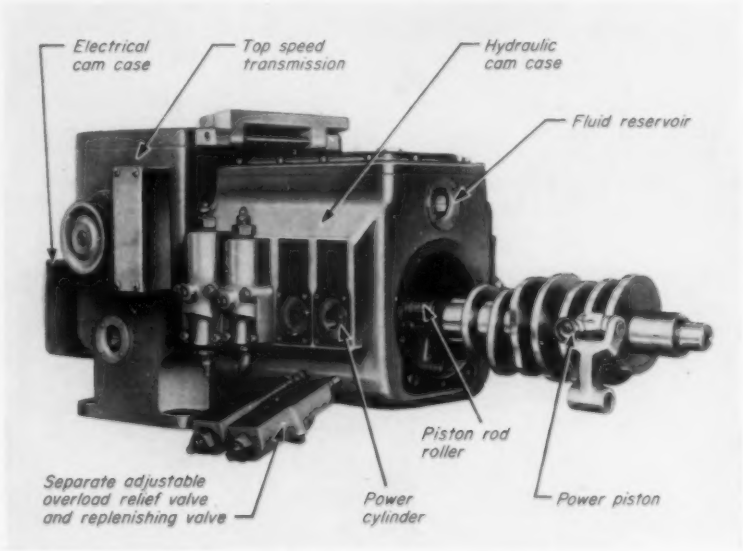
For more information—Circle 3, inside back cover

Multiple-Circuit Hydraulic Power and Control

This device consists of a series of hydraulic power cylinders, each connected to an individual closed hydraulic circuit, each cylinder is equipped with a power piston driven by one of a series of cams mounted on a common shaft. The cam shaft is powered through a two-speed transmission.

By varying the characteristics of the individual cams, various timing and sequence or overlapping of motions is obtainable, as well as any length of stroke within power cylinder limitations. Feeds, chucking, clamping, loading, unloading, gaging, are some of the functions available for machine tool steps which combine two or more operations in timed relationship. Each function has its own closed hydraulic circuit with overload protection.

Cycles can be as fast as 1 per sec. The two-speed drive provides for both the work and idle cycles. Feed rates are said to be unaffected by changes in fluid viscosity. Any type motion can be produced.

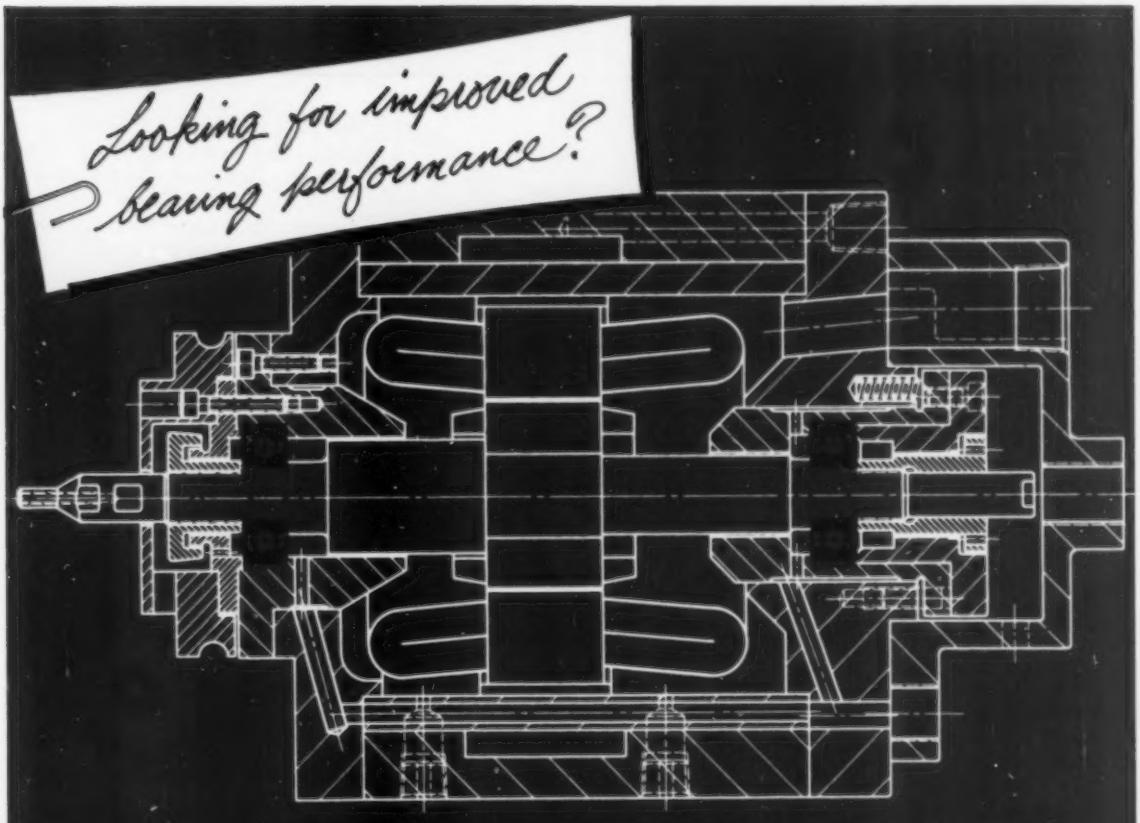


The hydraulic fluid is always under pressure to exclude air. The return stroke of each power piston is actuated by energy stored in an accumulator during the power stroke, so the piston rod roller is always in contact with its cam. Any desired number of hydraulic circuits can be provided. The device is compact, efficient and easily serviced by regular repair men. It can be retooled for other applications. Earl A. Thompson Mfg. Co., 1300 Hilton Road, Ferndale, Mich.

For more information—
Circle 4, inside back cover

CONTINUED ON PAGE 230

Looking for improved bearing performance?



over 14 billion revolutions...

— and still going strong

Fafnir Super-Precision MM201W1-CR spring-loaded ball bearing, the type specified for wheelhead illustrated.

Fafnir-equipped, high-speed, oscillating grinder wheelhead demonstrates machine tool progress in performance

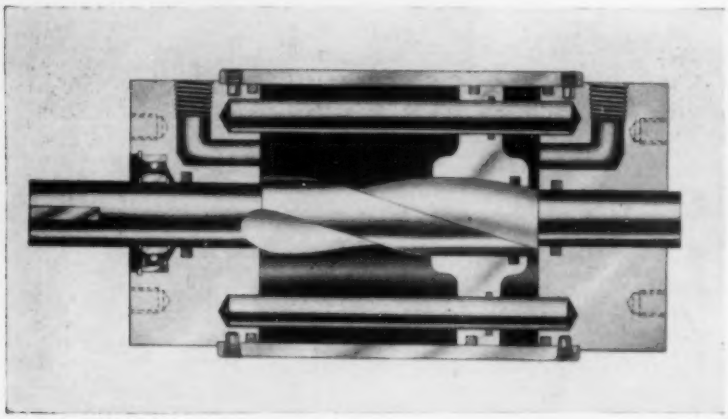
This extraordinary record has been made on the production line by a Pope-built wheelhead, grinding the races of extra-precision ball bearings. The hi-frequency motorized wheelhead operates at 72,000 rpm. The motor is water-cooled and bearings lubricated by means of an oil-air mist system.

When designing this oscillating grinder wheelhead, Fafnir engineers worked together with the Pope Machinery Company engineers in the selection and application of bearings. The type of bearing recommended is shown at the left and its application in the drawing above. Its performance record, according to Pope, demonstrates progress to match today's improved machine tools.

Whatever your bearing problem, a few minutes spent with a Fafnir representative may be the means of solving it as successfully. Write The Fafnir Bearing Company, New Britain, Connecticut.

FAFNIR
BALL BEARINGS

MOST COMPLETE LINE IN AMERICA



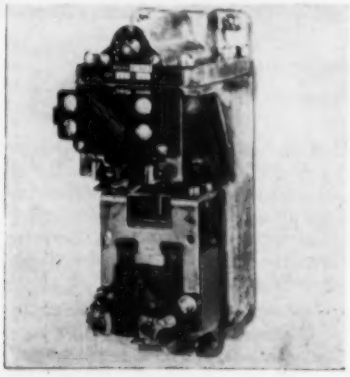
Actuator Provides 360 deg Rotation

This rotary actuator is a self-contained unit designed to operate on air, gas, water or oil pressure. It delivers rotary motion by means of a piston and internal helix. Some present applications include indexing, positioning, transfer mechanisms, valve actuating ratchets, gate opening, dumping, cam actions, mixing, power takeoffs, rolling, clamping, lifting.

The unit can be stopped at any point in the rotation cycle and held there at balanced pressure indefinitely without relaxing. In the event of power failure the actuator will remain in position. The actuator is totally enclosed.

Through the use of thrust bearings, it is said to be possible to operate the actuator with pressures of 5 to 500 psi. The actuator is being made in standard sizes of 3, 4, 5, 6 and 8 in. dia. Standard rotation cycles are: 0 to 100 deg; 0 to 190 deg; 0 to 280 deg; 0 to 370 deg. Carter Controls, Inc., 2800 Bernice Road, Lansing, Ill.

For more information—
Circle 5, inside back cover



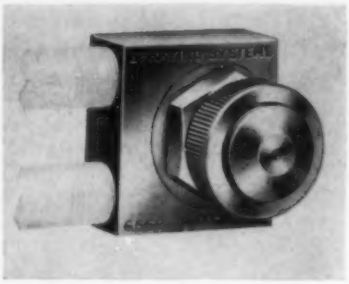
Pneumatic Timer for Control Circuits

A pneumatic timer for use in automatic control circuits such as machine tool sequencing, process industry operations and cranes has a time delay of ½ to 180 sec, with an accuracy of ±10 per cent of setting. Cast frame construction is said to resist shock and vibration and provide a stable timing element and housing.

Wiring terminals are accessible from the front of the unit and are mounted on plastic supports. A filtered vertical air intake, in an enclosed air space, helps keep dust from entering the orifice to change time intervals or affect the operation.

Operation of the timer can be changed from on-delay to off-delay simply, and requires only a screwdriver, with no extra parts needed. The timing element with timing contacts is available independently for mechanical connection to certain of this manufacturer's contactors and also for separate use. Units can be supplied with a maximum of two instantaneous interlocks. Optional enclosures are NEMA type 1 general purpose, NEMA type 4 and 5 water or dust-tight, and NEMA type 7 class 1 group D enclosure. Timers are available for operation at standard voltages and frequencies. General Electric Co., Schenectady 5, N. Y.

For more information—
Circle 6, inside back cover



Miniature Atomizing Nozzle

The body of this nozzle is ¼ x 1-5/32 x ½ in. Depth of the nozzle cap will depend upon type employed. Both liquid and air inlets are on the same side.

This pneumatic nozzle is supplied in a wide range of capacities, with round, wide-angle round and flat sprays. Made in brass or stainless steel. Spraying Systems Co., 3201 Randolph St., Bellwood, Ill.

For more information—
Circle 7, inside back cover

Coupling With Molded Rubber Teeth

Power transmission of rated load is achieved by gear teeth on end castings fitted into matching teeth of a specially molded rubber center section. This tubular section is composed of fibre reinforcement imbedded in heat and oil-resisting Neoprene. The strands absorb load pulsations and shock, providing torsional resilience with angles of twist up to 30 deg in the standard construction.

The coupling is manufactured in two basic hub sizes with a choice of

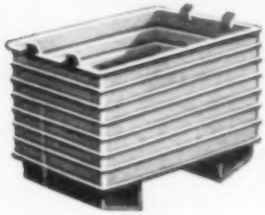
CONTINUED ON PAGE 232

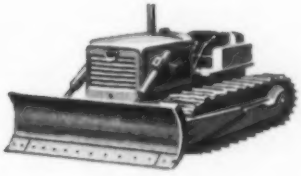
MAKE IT WEIGH LESS

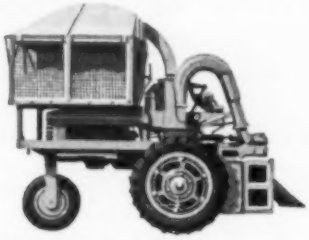
N-A-X

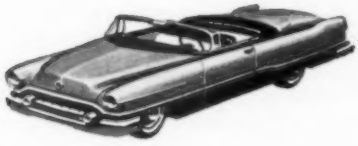
HIGH-TENSILE STEEL

MAKE IT LAST LONGER









You can design light weight, longer life, and economy into your products by including N-A-X HIGH-TENSILE in your plans.

- It is 50% stronger than mild steel.
- It is considerably more resistant to corrosion.
- It has greater paint adhesion with less undercoat corrosion.
- It has high fatigue life with great toughness.
- It has greater resistance to abrasion or wear.
- It is readily and easily welded by any process.
- It polishes to a high luster at minimum cost.

And, with all these physical advantages over mild carbon steel, it can be cold formed as readily into the most difficult shaped stamping.

When you next start to redesign, get the facts on N-A-X HIGH-TENSILE. It's produced by Great Lakes Steel – long recognized specialists in flat-rolled steel products.

N-A-X Alloy Division

GREAT LAKES STEEL CORPORATION

Ecorse, Detroit 29, Mich. • A Unit of

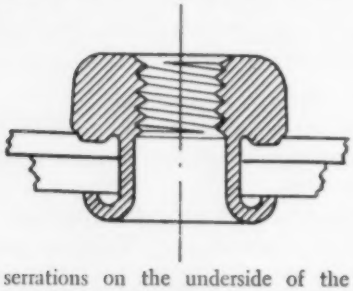
NATIONAL STEEL CORPORATION

two-ply, four-ply or six-ply flexible elements to increase respective torque capacity for each hub size. The six combinations are said to satisfy standard requirements for electric motors from 2½ to 25 hp. Guardian Products Corp., Dept. A-13, 1215 E. 2 St., Michigan City, Ind.

For more information—
Circle 8, inside back cover

Rivet-Nut Fastener Combination

This device will permanently hold two or more pieces (as a rivet) and fasten others by functioning as a nut. Basically, the new fastening device is a tubular rivet with a hole in the head tapped with standard threads. Radial



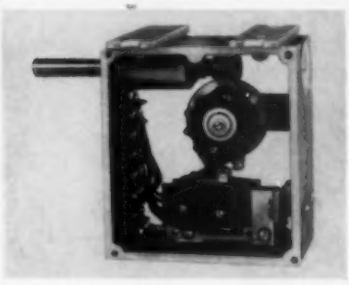
serrations on the underside of the head bite into the workpiece, preventing the nut from turning, once it has been clinched.

Capable of being set automatically at production rates on conventional riveting machines, the fasteners allow permanent installation of a nut in an area which may be hard to reach, or blind after final assembly. It is available in steel, brass, or aluminum, in seven standard styles with head diameters ranging from 9/32 to 13/32 in. Tubular Rivet & Stud Co., Wollaston (Quincy) 70, Mass.

For more information—
Circle 9, inside back cover

Rotating Limit Switch

A rotating limit switch with heavy duty pilot ratings to 480 v incorporates two single-pole, double-throw, snap-action contact assemblies. A cast aluminum housing (shown with cover plates on each side removed) provides



accessibility for wiring. Bearings on the input shaft together with heavy duty worm and cam gears are provided. Adjustment of cams and snap switches is possible.

These switches are used to limit the travel of electrically operated doors, conveyors, hoists and similar mechanisms. They are also used as pilot controls to operate solenoids of magnetic reversing starters or contactors. Furnas Electric Co., 1050 W. McKee St., Batavia, Ill.

For more information—
Circle 10, inside back cover

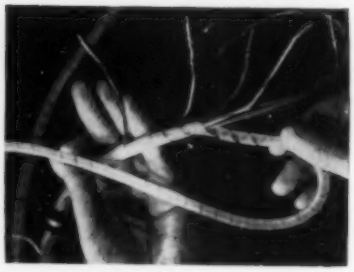
Subminiature Relay

A two-pole, hermetically sealed relay with positive adjustment of contact and plunger travel after the enclosing can has been put into place. This is accomplished by the use of a screw-like attachment. After adjustment the outside portion of the screw is cut off and the area sealed over.

The subminiature relay is ideal for electronic applications in aircraft, aboard ship, and on portable units according to the manufacturer.

The unit can withstand shock in excess of 50 g and ambient temperatures as high as 125 C, and has a contact rating of 2 amp resistive load, 28 v dc, or 115 ac. It will withstand vibrations at 10 to 55 cps at ⅛ in. max excursion or at 55 to 500 cps at 15 g acceleration. The unit weighs approximately 1 oz and measures 1.77 x 0.651 in. dia, max. General Electric Co., Schenectady 5, N. Y.

For more information—
Circle 11, inside back cover



Spiral Wire Wrapping

Spiral-cut tubing of insulating plastic is quickly wrapped around wire bundles up to 2 in. dia. Individual wires are easily lead out or entered through the spiral-cut. Leads are formed into a cable which is firm but can be formed to any desired shape.

A single size of this wrapping, having a ¼ in. initial diameter, is said to serve nearly all cabling needs. Computer Control Co., Inc., Wellesley, Mass.

For more information—
Circle 12, inside back cover

Quick Disconnect Coupling

A quick connect-disconnect fluid coupling for acids, alkali, solvents, high pressure steam has Teflon nipple seals and valve seats. The unit will function through a temperature range of −100 to 500 F, and can be subjected to lower and high temperatures for short periods. Manufactured from solid bar stock, the coupling can be

CONTINUED ON PAGE 234

NEW KAYDON THIN-SHELL NEEDLE BEARINGS

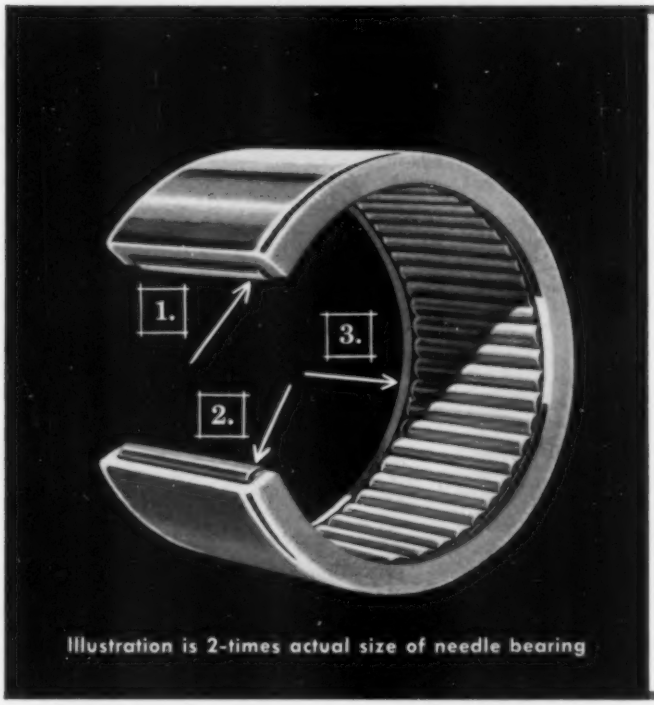
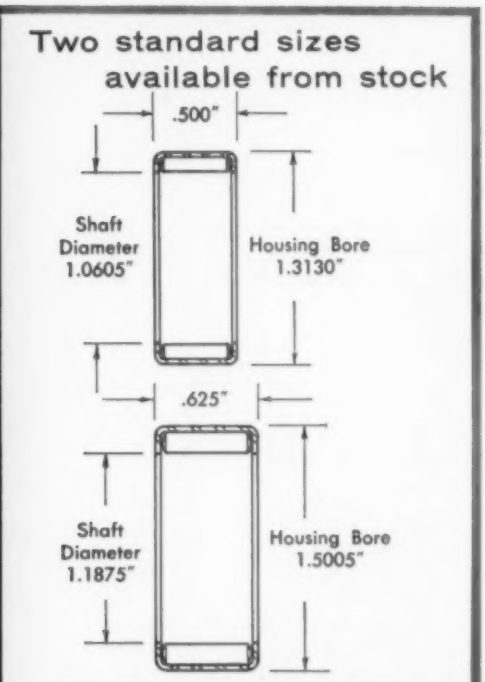


Illustration is 2-times actual size of needle bearing



You get these Kaydon design advantages:

1. **Greater effective length needle rollers for MORE CAPACITY (41% on ½" width)... LONGER LIFE (2.8 times as much on ½" width)**
2. **Simplified construction that SAVES you money**
3. **Pre-packed lubrication that SAVES assembly time**

HERE it is! Kaydon's new thin-shell needle bearing. A bearing that gives you more of everything — more capacity... more economy... *plus longer life* than any other comparable bearing, because of greater effective length of spherical end rollers.

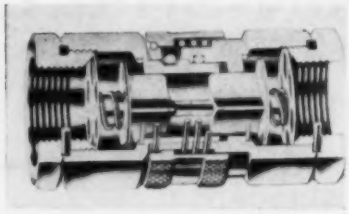
This new bearing is ready for you right now from stock in two standard sizes (illustrated). Other sizes will be available later.

For complete specifications, ask for Data Sheet No. K562—write, call or wire Kaydon of Muskegon.

THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

All types of ball and roller bearings — 4" inside diameter to 124" outside diameter... Taper Roller • Roller Thrust • Roller Radial • Bi-Angular Roller • Spherical Roller • Needle Roller • Ball Radial • Ball Thrust Bearings



furnished in types 303 and 316 stainless steels, brass, aluminum, special carbon steel, or from any machinable material.

The coupling is available plain or with automatic shut-off valves incorporated in either or both ends. The coupling is made in ¼ through 3 in. ID pipe sizes with any type end connection desired. Snap-Tite, Inc., Union City, Pa.

For more information—
Circle 13, inside back cover

Flexible Control Shafts

The core of these valve control shafts is made of multiple layers of precision wound high carbon wire. The casing is interlocked metal, asbestos-packed, and is available in either galvanized steel or phosphor bronze. This shafting is available with a variety of terminals, making it possible to control any type valve from almost any point.

These flexible shafts are available in core size diameters of ¼ to 1⅝ in., with torque input ratings of 20 to 250 lb-ft. Stow Mfg. Co., 426 Shear St., Binghamton, N. Y.

For more information—
Circle 14, inside back cover

Rate Gyro

The motor is d-c-powered, and governor-controlled so that output is independent of line voltage. The size is 2⅜ x 4 7/16 in. long and the weight is 1.7 lb. The case is designed to provide hermetic sealing. Standard units incorporate a potentiometer pickoff and also adjustable switches which can be set to close at any desired rate within the range of the unit. The standard unit also incorporates a dashpot for damping, and the natural frequency of the gyro is in the range of 5 to 10 cps. Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.

For more information—
Circle 15, inside back cover

D-C Power Supply

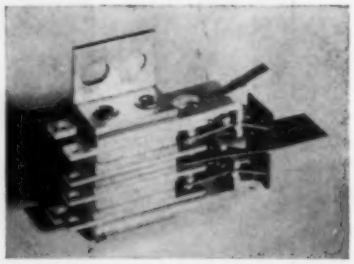
An electronic transistorized d-c to d-c power supply that produces 16,000 v from as little as 3 v input weighs 1½ lb, and is 1½ x 3 x 6 in. Standard ambient temperature range is −25 C to 75 C. Universal Atomics Corp., 19 E. 48 St., New York 17, N. Y.

For more information—
Circle 16, inside back cover

Simultaneous Action Switch

A double-pole, double-throw basic switch has functions which include limiting, reversing, and starting and stopping of automatic assemblies. Applications are in search tune radios, level control equipment, portable tools, appliances, automotive equipment.

The switch is available with either sustained contact action (reset action) or momentary contact action (return action). Movement differential and operating force may be varied for specific switch applications, minimum overtravel is 0.075 in. Cherry Electrical Products Corp., 1644 Deerfield Road, Highland Park, Ill.



For more information—
Circle 17, inside back cover

Appliance Relay

This relay is available either in single-pole, normally open or two-pole, normally open versions, with either screw or quick connect terminals available. Contact ratings per pole at 230 v are 25 amp resistive, or 20 amp inductive. Approximate overall dimensions, 2 21/64 x 2 35/64 x 2¼ in.; with UL-approval. Essex Wire Corp., 1601 Wall St., Fort Wayne, Ind.

For more information—
Circle 18, inside back cover

Tachometer-Servo Unit

A size 15 servo motor combination has a drag cup tachometer with a low null voltage of 0.008 v ac, max of fundamental and 0.013 v ac, rpm.

CONTINUED ON PAGE 236

Standard Steel forged flanges
cut manufacturing costs for Elliott Company

For the heavy bolting ring flanges on their synchronous condenser shells, Elliott Company has turned to Standard Steel forged flanges. They get a better product at lower cost because:

- Flanges are forged very close to final tolerances, so expensive machining time is greatly reduced.
- Uniform grain structure permits faster drilling of bolt holes—40 in each flange.
- The high strength of Standard Steel forged flanges provides an ample safety factor to withstand any accidental explosion pressures.

Next time *you* need rings, flanges, gear blanks, shafts, wheels, or special shapes —and need them fast—get our quotation first. For bulletin 10,000, write Dept. 8835, Standard Steel Works Division, BLH Corporation, Burnham, Penna.

BALDWIN BLH LIMA-HAMILTON

STANDARD STEEL WORKS DIVISION
BALDWIN-LIMA-HAMILTON

DIVISIONS: Austin-Western • Eddystone • Hamilton • Electronics & Instrumentation • Lima • Madsen • Loewy-Hydropress • Pelton • Standard Steel Works

Output voltage is 3.2 v ac, per 1000 rpm. Input is 115 v ac, 400 cps on first phase and 115 or 230 v ac, on the control phase. Torque is 1.5 in-oz at stall. No load speed is 4500 rpm. Basler Electronics, Inc., Highland, Ill.

For more information—
Circle 19, inside back cover

Seal Fitting for Threaded Connections

The seal fitting is installed by: 1—threading it on pipe or fitting; 2—threading pipe or fitting "hand-tight" to desired position in port; 3—tightening down against pipe or fitting with only light torque required. It is designed for use on any pipe thread, dry seal or standard, for operating temperatures of −280 F to 500 F., for pressures up to 3,000 psi. Flick-Reedy Corp., 2040 N. Hawthorne Ave., Melrose Park, Ill.

For more information—
Circle 20, inside back cover

Malfunction Detector

This vibration monitor is said to anticipate and prevent trouble in rotating and reciprocating machines by responding to slight increases in roughness or vibration to cause a shutdown. Examples of detectable malfunctions are failing bearings, bent shafts, imbalance, broken blades. Applications include pumps, motors, compressors, blowers, gas engines, diesels, centrifuges, turbines, generating equipment, test stands.

It may be used singly on small equipment, in pairs on driving and driven equipment, in series or parallel combinations to monitor bearings. Acceleration range is 0 to 2 g, to cover all types of rotating equipment at speeds up to 18,000 rpm.

The Model 5 includes a shock-free holding and reset mechanism for automatic or remote operation to prevent actuation from starting or from normal or accidental transient shocks. The housing is of cast aluminum, threaded for ¾ in. conduit.

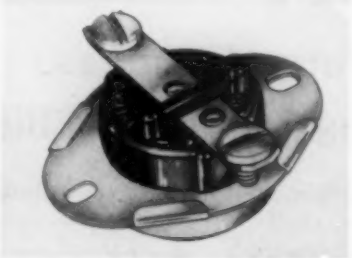
Switch contacts are single-pole, double-throw, rated at 7 amp up to 440 v, ac. Beta Corp., Forest Ave. at Ridge Rd., Richmond 26, Va.

For more information—
Circle 21, inside back cover

Small High-Capacity Thermostats

The resistive load is 6000 w at 240 v ac., 3000 w at 120 v ac. The thermostats are preset, snap action, non-adjustable.

They can be used for operating temperatures up to 350 F, and are for single-pole, single-throw operation;



can be supplied with normally open or closed contacts. Units are available with inclined blade, horizontal blade or screw terminals, surface or air stream mountings. Therm-O-Disc, Inc., Mansfield, Ohio.

For more information—
Circle 22, inside back cover

Variable Speed Transmission

For machines using up to 10 hp V-belt drives, speed ranges up to 10:1 are provided. The machine operator effects desired speed change by moving a speed control handle. There is no interruption in operation. Maurey Mfg. Corp., 2915 S. Wabash Ave., Chicago 16, Ill.

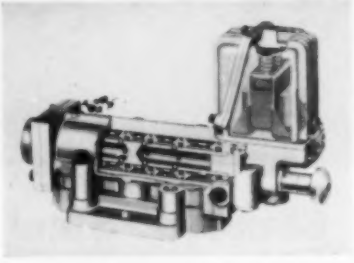
For more information—
Circle 23, inside back cover

Vinyl Dip Coating

A vinyl coating that is deposited by a dipping operation has a high dielectric strength, and is not dissolved by oils, greases, aliphatic hydrocarbons, alcohols or glycols. It is resistant to inorganic acids, alkalies, oxidizing agents, and salt-solutions at temperatures up to 20 0F.

Curing time is short and depends on the size of the article and thickness of coating. The coating is available in blue, green, red and yellow colors. Beckett-Harcum Co., 1087 Wayne Road, Wilmington, Ohio.

For more information—
Circle 24, inside back cover



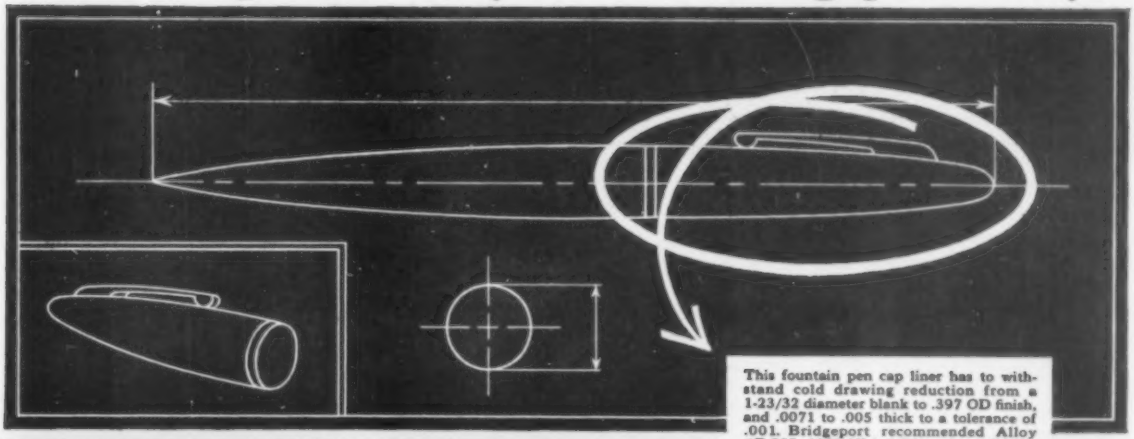
Air and Hydraulic Valves

Valve chambers of these valves are formed by aluminum spacers held in metal-to-metal end abutment. This permits the O-rings or U-packings to be supported on both the inside and outside diameters without placing any mechanical pressure on the packings.

The hollow, radially ported, stainless steel, ground and polished plunger is the only moving part, except the operating mechanism. Flow is from the inlet chamber through the radial

CONTINUED ON PAGE 238

Matching metal to job with Bridgeport alloys



This fountain pen cap liner has to withstand cold drawing reduction from a 1-23/32 diameter blank to .397 OD finish, and .0071 to .005 thick to a tolerance of .001. Bridgeport recommended Alloy #F-565, 18% Nickel-Silver, in grain size and temper developed by Bridgeport for applications of this type.

Parts made by Advance Stamping Co., Detroit, Mich.

For better stamping, drawing, cold forming... Bridgeport **HIGH I. Q.*** Strip and Sheet

Let Bridgeport match the metal to the job! Tell us your requirements—both working and service properties—and our Technical Service will be glad to recommend the right Bridgeport High I.Q. alloy for the job. The right alloy may help you cut production costs and produce a better product. Call your Bridgeport sales office today for a metal recommendation to fit your specific needs.

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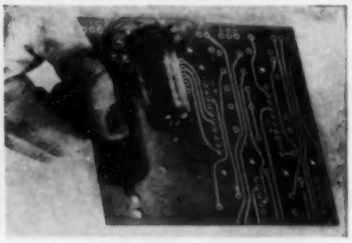
ports of the hollow plunger and out through other ports in the plunger to the connected line. These solenoid-operated valves are rated at 600 cps for continuous operation on air at pressures from 40 psi to 150 psi. They can be operated at much higher speeds for intermittent duty on air at 80 psi to 100 psi.

Exterior feed valves can be used in hydraulic service at pressures up to 250 psi, using air for the pilot medium. Interior feed valves can be used on oil from 40 to 150 psi at somewhat lower cycling speeds. Available in single and double solenoid; also lever and single and double piloted designs. C. B. Hunt & Son, Inc., Salem, Ohio.

For more information—
Circle 25, inside back cover



Right-Angle Tube Socket

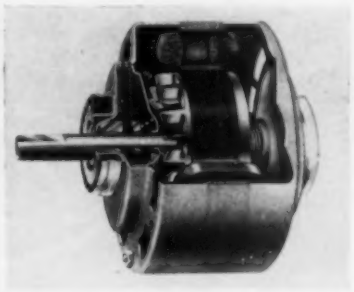
An angle socket has been designed for use in electrical and electronic units, in conjunction with printed circuits. Supplementary buttress ribs maintain the angle position of the socket to the printed circuit. Cleveland Metal Specialties, 1783 E. 21 St., Cleveland 14, Ohio.

For more information—
Circle 26, inside back cover

Fhp Motors With 5 Yr Guarantee

A 5-yr guarantee on two lines of 42-frame fhp motors has been offered on factory-approved applications. These shaded pole and permanent-split capacitor units are applicable to room air conditioners, unit heaters and coolers, furnace blowers and window fans.

Self-aligning bearings are said to incorporate a steel-backed, babbitt-



lined sleeve bearing mounted in a die-cast spherical cup; Original oil supply in each bearing reservoir is expected to provide ample lubrication for at least 5 yr of normal operation. The Type FE motor is a constant speed, switchless type. It is rated 1/30 to $\frac{1}{8}$ hp on 115 or 230 v, 60 cps, at 1050 rpm. Type FLL permanent-split capacitor motor is also a constant-speed switchless motor. It is rated 1/30 to $\frac{1}{4}$ hp on 115 or 230 v, 60 cps, at 1075 rpm. Westinghouse Electric Corporation, P. O. Box 2099, Pittsburgh 30, Pa.

For more information—
Circle 27, inside back cover

High Torque Timing Motor

A synchronous timing motor develops high torque while retaining the many advantages of hysteresis type motors. The motor is designed for high-volume applications in the appliance, vending, animated display and industrial fields.

Torque rating is 10 in-oz at 1 rpm; speeds are 1, 2, 4, 6, 8 and 10 rpm in right and left-hand rotation. One-way and two-way frictions available. Heavy duty gear train permits transmitting continuously full out-put of the motor. Motor is 1 13/32 in. from front to back. The drive can be supplied in 115 or 230 v, 60 cps. Haydon Mfg. Co., Inc., 245 E. Elm St., Torrington, Conn.

For more information—
Circle 28, inside back cover

Automatically Calibrated Digital Voltmeter

A four-digit voltmeter with one-digit accuracy, automatic calibration, 0.01 per cent stability has a voltage range of 0.001 to 999.9 v. Input impedance is 1,000 megohm on 9.999 scale and 11 megohms on other scales. Calibration is continuous and automatic, as is polarity and range switching.

The Model 1040 measures 7 x 19 in. for rack mounting and operates on 115 v, 60 cps; power required is 80 w. Electro Instruments, Inc., 3794 Rosecrans St., San Diego, 10, Calif.

For more information—
Circle 29, inside back cover

Torque Measurement Transducer

A variable permeance torque transducer operates without brushes and slip rings. It is designed for either static or dynamic torque measurement.

Reproducibility of 0.1 per cent and resolution of 0.02 per cent permit one instrument to serve over a wide range of torque measurement scales. Various models are available for ambient temperatures from −145 F to 1200 F. Linearity of all models is 2 per cent.

The transducer can be operated into

CONTINUED ON PAGE 240

Using

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NEOPRENE • HYPALON®

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HYPALON® can be compounded in an unlimited range of weather-resistant colors

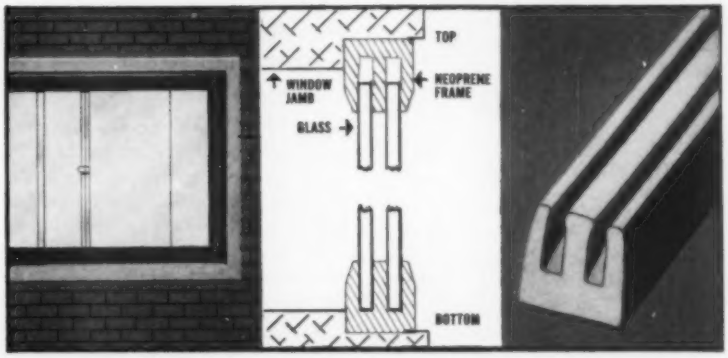
HYPALON, Du Pont's new synthetic rubber, brings brilliant color to the design field as well as superior performance for rubber materials. Since HYPALON does not require carbon black as a reinforcing agent, a complete range of stable, weather-resistant colors is possible. Colored compounds of HYPALON start bright . . . *stay* bright despite severe exposure conditions.

TWO YEARS of outdoor exposure with virtually no trace of color failure, thanks to the superior color stability of HYPALON.

In addition to outstanding color stability, HYPALON has many other advantages that can help your products give *extra-long service* on industry's toughest jobs. Compared to other kinds of rubber, HYPALON shows unusual resistance to hardening at elevated temperatures (250°-350°F.). It is completely resistant to ozone and has exceptional resistance to strong oxidizing agents such as chromic acid.

When your design calls for a resilient material that must have extra-high resistance to ozone, heat and chemicals, it will pay you to take a close look at HYPALON. For more information, just mail coupon.

Resilient NEOPRENE window frame cuts installation and maintenance costs



NEOPRENE CHANNEL STRIP makes this window air- and water-tight, easy to install.

The Silent Glide Corp. of New Jersey has reported the development of a new sliding-window design using a resilient neoprene frame that can be installed by semi-skilled labor and requires no maintenance. Over 5,000 such installations have been made in housing developments to date.

The window consists of two plate-glass panes sliding in extruded channels made of light-gray neoprene synthetic-rubber composition. The slotted strips are cut from continuous lengths of neoprene extrusions to fit various size windows, mitered, then cemented and stapled in place. The glass panes are ground and polished and installed by inserting them into the top of the frame and dropping them into the grooves in the lower strip.

The resilient neoprene strips seal the glass, yet allow the panes to slide easily. Neoprene requires no protective paint or chemical coating, because it resists weather and sunlight attack as well as acid fumes encountered in industrial areas. It will not warp, chip, crack, soften or harden. The manufacturer gives this explanation of his use of neoprene: "Our window frames must be good for the life of the building. That's why we're using neoprene. We've seen neoprene parts functioning perfectly after being in service outdoors for over 15 years."

Perhaps your product design can benefit from an evaluation of the properties of neoprene. We'd be glad to send you further information. Just fill in and mail the coupon below.

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Wilmington 98, Delaware

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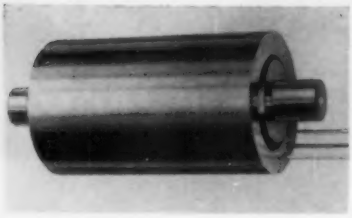


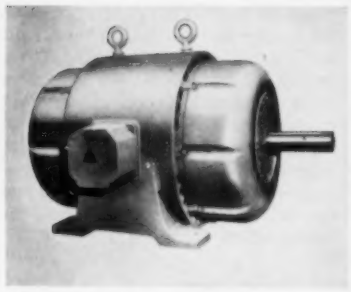
all conventional recorders and amplifiers which employ a-c bridge circuitry, and into other equipment with a slight modification. Crescent Engineering & Research Co., 11632 McBean St., El Monte, Calif.

For more information—
Circle 30, inside back cover

Sealed Trimming Potentiometer

A trimming potentiometer, subminiature in size, is designed to meet or exceed military humidity specifications. It is furnished with wirewound or carbon resistance element. The wirewound unit will operate at 135 C, and dissipate 0.4 w at 50 C. Instrument is screwdriver adjusted over 25 turns, with a self-locking shaft for stable settings. Bourns Laboratories, 6135 Magnolia Ave., Riverside, Calif.

For more information—
Circle 31, inside back cover



Fan-Cooled Motors, 50 to 200 Hp

A totally enclosed motor in the size range 50 to 200 hp has a double-end ventilation system. Two external cooling fans, one at each end, draw cool, fresh air directly across each bearing, then drive it the length of the motor through large cooling tunnels cast in the walls of the main frame.

Slot cell insulation is Mylar, bonded to electrical paper, stator is insulated with Delcote, a combination of insulating varnish and cotton fiber flock.

Bearings are open type with provision for regreasing and pressure relief without removing any part of the motor. Delco Products Div., General Motors Corp., Dayton, Ohio.

For more information—
Circle 32, inside back cover

Miniature Printed Circuit Connectors

The connectors in production at present have 0.040 in. dia pins with 0.312 in. spacing and are for 1/16 in. thick printed circuit boards. Also available are printed circuit connectors having 0.200, 0.300 and 0.400 in. pin spacing. The pins can be furnished with 0.030, 0.040 and 0.050 in. dia for 1/32, 1/16 and 3/32 in. thickness boards. Nugent Electronics Co., 621 E. 8 St., New Albany, Ind.

For more information—
Circle 33, inside back cover

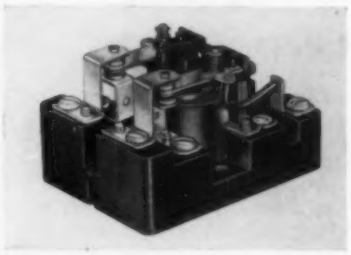
Porous Glass Epoxy Tubing

This material is produced to provide a controlled degree of porosity in the tubing wall. It is achieved by variations of glass fiber weave, resin formula and impregnation process.

Temperature resistance ranges as high as 350 F. Diameters are available down to 0.062 in. ID, with wall thickness down to 0.005 in.

Choice of cross-section includes round, square, oval, triangular. Standard lengths up to 9 ft. Weight: 0.03 lb/cu in. Lamtex Industries, Inc., 51 State St., Westbury, N. Y.

For more information—
Circle 34, inside back cover



Power Relay

Heavy duty 25-amp, power relay is designed to meet UL-specifications. Present applications include motor starting, heater loads and industrial control systems. By removing two easily accessible screws, the complete coil assembly can be removed and replaced in a few minutes by a coil of the same or different value ranging from 6 to 230 v ac. Contacts are rated at 25 amp, continuous duty, 230 v ac, with 75 per cent power factor load. Standard unit is double-pole, double-throw. Relay measures 3⅜ x 2½ x 2⅞ in.; weighs 11 oz. Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago 12, Ill.

For more information—
Circle 35, inside back cover

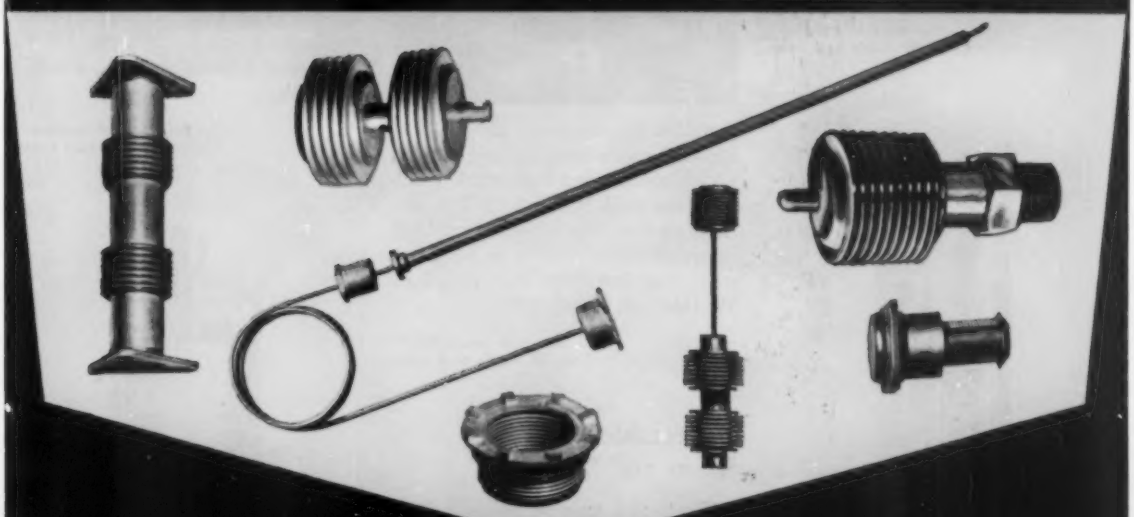
Programmable Power Packs

These power supply units are intended for applications requiring remote control or programming, according to commands from an operator or automatic control system. They have main and vernier controls, auxiliary bias and filament outputs, as well as regulation over full range and for all load conditions.

All units have an output range of

CONTINUED ON PAGE 242

HOW TO SAVE TIME AND MONEY ON COMPLETE BELLOWS ASSEMBLIES



No matter why or how the bellows principle enters into an assembly, Fulton Sylphon can assemble the right bellows and related accessories or mountings into a complete device that meets your specifications. In doing this Fulton Sylphon offers important design help, specialized skill in joining bellows with other members, and modern production facilities for on-time deliveries.

FULTON SYLPHON BELLOWS HEADQUARTERS, U.S.A.

As the No. 1 source for bellows and bellows assemblies, Fulton Sylphon furnishes a wide range of characteristics and sizes in many different metals. Single or multiple ply, and braid covered bellows constructions are available for various abrasive and pressure conditions.

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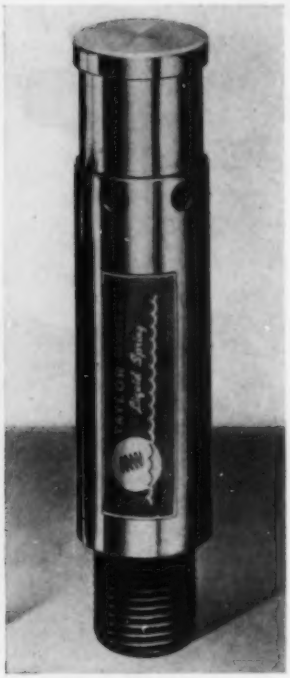
0 to 300 v, regulation of 0.1 v, and ripple of only 1 mv. Current outputs for various models are 0 to 100, 0 to 200 and 0 to 300 ma. Electronic Measurements Co., Inc., Lewis St., Eatontown, N. J.

For more information—
Circle 36, inside back cover



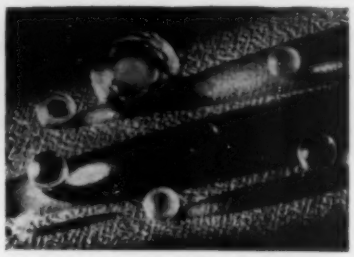
Liquid Compression Springs

The manufacturer claims that this liquid spring, designed for draw dies, doubles the stroke of equivalent coil springs while tripling the preload and end load with low spring rates and high spring force. It is 1 x 3½ in. long with a ⅜ in. stroke, with a 480 lb preload and end force of 1,000 lb. Taylor Devices Inc., 188 Main St., N. Tonawanda, N. Y.

For more information—
Circle 37, inside back cover

Precision Ground Glass Balls

These Pyrex and optical crown glass balls are non-conductive and unaffected by heat and cold. They are



useful in the electronic field and in applications where resistance to a variety of corrosives is essential. Available from stock from 1/16 to 1 in. dia. Accuracy is maintained within ±0.001 in. on diameter, 0.0005 in. on sphericity. Hartford Steel Ball Co., Inc., W. Hartford, Conn.

For more information—
Circle 38, inside back cover

Cementable Teflon Sheets and Tapes

Sheets and tape of Teflon treated in one or both sides can be cemented to a variety of materials or to itself, using commercially-available adhesives. Steel, aluminum, wood, plastics, cardboard, or rubber can be used. Tape is available, treated one or both sides, in thicknesses ranging from 0.005 in. to 0.125 in., up to 24 in. width. Teflon sheet, treated one or both sides, is available in thicknesses from ⅛ to 1½ in., and 12 x 12 in. standard sheet sizes. Shamban Engineering Co., 11617 W. Jefferson Blvd., Culver City, Calif.

For more information—
Circle 39, inside back cover

Ten-Channel Electronic Switch

This switch will sample up to ten separate signal sources and put them out in sequence on a single line. One application is as an accessory to the conventional single channel oscilloscope. It is claimed that this instrument will provide the user with the advantages of multi-channel oscillography at a mere fraction of the cost of a multi-channel scope. Individual position and amplitude controls for each of the ten input channels allow vertical positioning of all the signals on the face of the oscilloscope so that they may be superimposed or placed in any desired relationship.

Available as a standard rack-mounting unit or in its own cabinet, the instrument contains a regulated power supply for a standard 60 cps, 115 v, a-c source. Burroughs Corp., Detroit 32, Mich.

For more information—
Circle 40, inside back cover

Hydrogen Thyratron

Designed for mobile and aircraft applications requiring moderately high power, this tube is rated for 5 g vibration from 60 to 500 cps, and 3 g from 500 to 1200 cps—also for 60 g high impact shock in any direction. Electrical ratings are 8.0 kv peak anode voltage, 90 amp peak current and 100 ma maximum anode current. It is rated for ambient temperature range of −50 C to 90 C and for an altitude of 10,000 ft in air. Bomac Laboratories, Inc., Salem Road, Beverly, Mass.

For more information—
Circle 41, inside back cover

Solenoid Control Valve

Measuring 4 9/16 x 3 5/16 x 1¾ in. wide, this air or hydraulic valve is available in both three-way (three-port) and four-way (five-port) types, for all popular a-c or d-c voltages. Valve is designed for oil hydraulic or air circuits

CONTINUED ON PAGE 244

MAGNETO DESIGN SERVICE

Call on Fairbanks-Morse for help in solving your magneto ignition problems!

YOU CAN PROFIT many ways by submitting your magneto ignition problems to Fairbanks-Morse engineers.

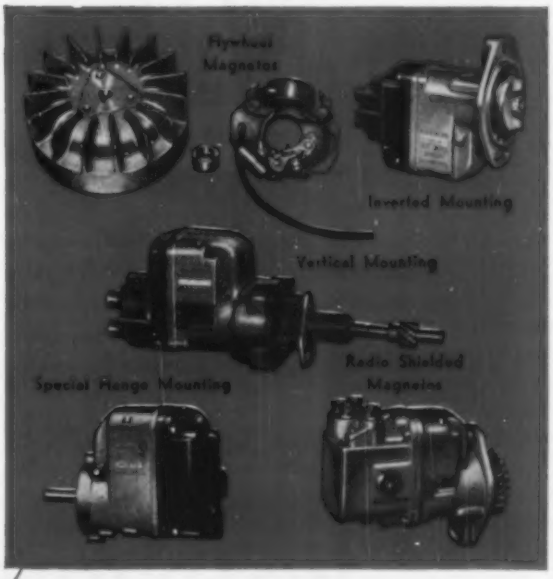
First, you get improved product performance because Super-Spark magnetos are tailored to fit your equipment and give you the kind of dependability; easy starting; simple, rugged design; and economical performance you *and your customers* expect.

But Fairbanks-Morse offers more than engineering advances and precision manufacturing. The wide selection of more than 400 different magnetos in our line enables us to use standard components, keeping manufacturing costs down and giving you higher quality at a lower price.

Your new product plans are always treated in complete confidence. Only the men working on your project know about it. And . . . after design and field testing, Fairbanks-Morse is equipped to manufacture and ship in accordance with your schedule requirements.

Also important to you and your customers . . . Fairbanks-Morse assumes complete responsibility, from design studies to field service. More than 2,500 authorized service stations throughout America are equipped to handle repairs, replacements, and parts for more than 3,500,000 Super-Spark magnetos now in use.

So, whatever your special requirements may be: radio shielding, fungus protection, special mounting, flywheel application, heavy-duty design, or extra voltage output — call on Fairbanks-Morse for expert engineering and complete follow-through! Write to Fairbanks, Morse & Co., Magneto Division, Beloit, Wisconsin, for Bulletin FM75F.



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COUPLINGS

The motor driven boiler feed pump application pictured above needs a WALDRON coupling to make it a top engineering and mechanically perfect installation. That's why WALDRON is being specified by more and more pump and compressor manufacturers.

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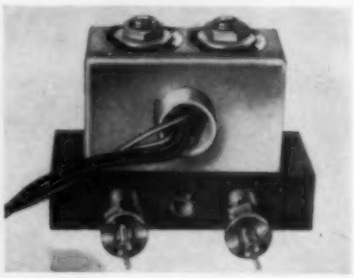
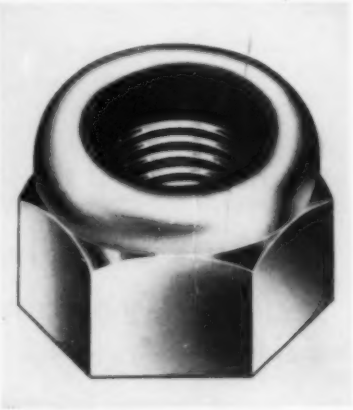


operating at 50 to 150 psi. It is available with exhaust speed control valves or open ¼ in. NPT female ports. Modernair Corp., 400 Preda St., San Leandro, Calif.

For more information—
Circle 42, inside back cover



Nut With Self-Locking Collar

A black, non-metallic collar provides a positive locking action of this nut in any position on the screw, whether seated or not. Manufactured in steel, aluminum, brass and stainless steel, the nut can be reused many times. Jacobson Nut Mfg. Corp., Box 177, Kenilworth, N. J.

For more information—
Circle 43, inside back cover

Plug-In Temperature Control

A thermistor-actuated temperature controller, designed as a plug-in unit, can be used in either single or multipoint temperature control systems. There are three elements: 1—the plug-in control unit, containing control circuitry, amplifier and relay on a chassis approximately 2½ x 7 in.; 2—

(Continued on page 247)

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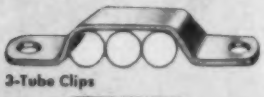
Satisfaction or your money back

CLIPS FOR ATTACHING TUBING

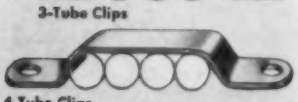
When ordering, specify ⅛", 5/16" or ¼" tubes. Style TF.

Single Clips

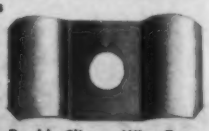
Double Clips



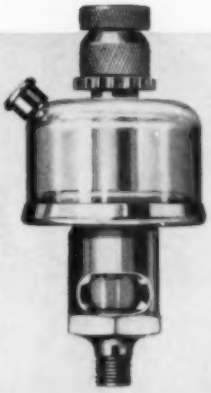
3-Tube Clips



4-Tube Clips



Double Clips — Wing Type

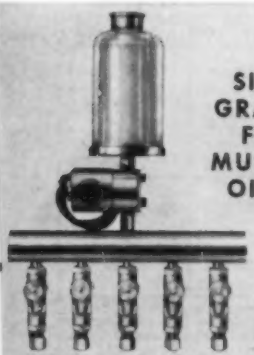


SIGHT GRAVITY FEED OILERS

Rate of oil flow regulated by needle valve, directly observed through sight glass in stem. Shut-off knob does not affect needle valve adjustment. Visible oil supply. Non-breakable. Tops in convenience and dependability, at low cost. Style NFU—No. 3602-A.

GEAR CASE GAUGES

This oil gauge plug permits instant checking of oil level within a transmission or gear case. For use where construction permits insertion in tapped hole. A valuable addition to any such equipment — at very low cost. Style BW—No. 4042.



SIGHT GRAVITY FEED MULTIPLE OILERS

This one unit replaces 3 to 8 individual oilers. Maximum practicality in a small central lubrication system. Positive cut-off during idle periods. Individual vibration-proof needle valve adjustments. With solenoid control (Illustrated): Style MDS—No. 4685-A. Without solenoid: Style MD.

SIGHT GAUGES

For use where rate of oil flow must be regulated to suit changing operating conditions. Needle valve permits extremely accurate adjustment of oil feed. Sight glass provides direct observation of rate of oil flow. Accuracy and convenience at a moderate price. Style PF—No. 4290.

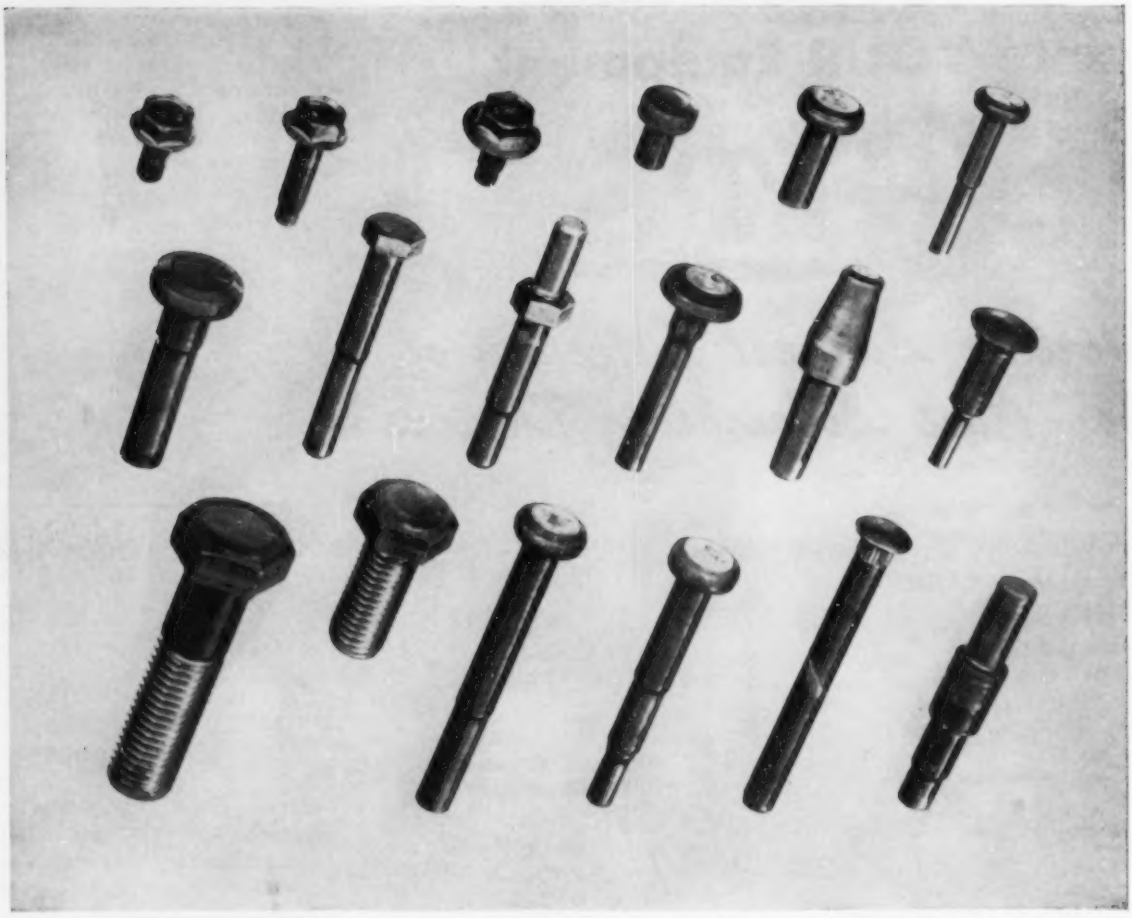
Don't price yourself out of the market. When you design proper lubrication into your equipment, specify GITS Lubricating Devices—the widest selection available anywhere. The items pictured above are only a few of our many thousands of lubricating devices. At the design stage, get the GITS story. Free Engineering Service. Send NOW for your free Catalog.

GITS BROS. MFG. CO.

The Standard For Industry For Almost Half A Century

1838-A South Kilbourn Avenue
Chicago 23, Illinois

Clip this page for handy "rough reference"



Is your part illustrated? These are representative of the shapes that can be cold formed more effectively with Granodraw.

GRANODRAW® PROCESS INCREASES TOOL LIFE 2-5 TIMES IN COLD HEADING STEEL FASTENERS

Thorough research, in cooperation with a leading manufacturer of headed fasteners, has proved the value of Granodraw phosphate coating of stock prior to cold working. Typical of the improvement in tool life and in production are the examples shown in the table.

But the advantages do not stop here in cold heading fasteners or cold working other products. This chemical treatment process permits greater speed of draw; greater reductions within the physical limits of the metal; more passes with the same number of intermediate treatments; and the possibility of fewer process anneals. It also results in less downtime of machines, better surface finish on products, cold forming of more complex shapes, fewer rejects, and a cleaner shop.

Write us for complete information about Granodraw and its application in cold forming operations.

PRODUCTION AND TOOL LIFE

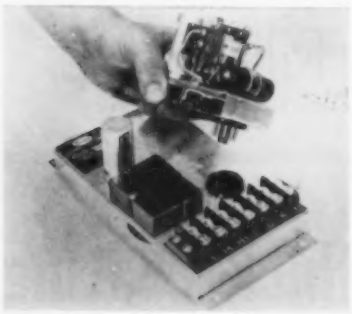
PRODUCT	MATERIAL		AV. PIECES PER DIE DRESSING	
	Tool	Stock	Granodraw-Treated	Other Treatment
⅜ x ⅜ rivet	Hardened Alloy Steel	1010 Steel	647,000	180,500
5/16 x 24 flat head shoulder bolt	Hardened Alloy Steel	1010 Steel	26,000	5000-8000
Hex Head Cap Screws	Hardened Alloy Steel	1038 Steel	53,000	13,000-14,000
¼ x 20 Hex Machine Bolt	Hardened Alloy Steel	1018 Steel	28,000	13,000

Note. Although investigations on the life of carbide tools are not completed, one item deserves mention. A 5/16 x 24 hex head shoulder bolt showed a strikingly low carbide tool life of 67,000 pieces per die. Using Granodraw-treated rod, one die produced 105,000 pieces—another 194,000 pieces. And both dies were in good condition at the end of the run.

AMERICAN CHEMICAL PAINT COMPANY, Ambler 17, Pa.

DETROIT, MICHIGAN ST. JOSEPH, MISSOURI NILES, CALIFORNIA WINDSOR, ONTARIO

CHEMICALS ACP PROCESSES



power supply on a separate chassis, containing the power transformer, terminal strip and socket to receive the male plug from the control unit; 3—Thermistor temperature-sensing probe. These three elements make up one controller which occupies 10 x 7 x 6 in.

A system for controlling temperature at multiple points can be set-up by grouping the required number of control units onto a single power chassis. Up to 100 plug-in controllers can be mounted on one chassis, so that control is centralized at a single location. The setpoint adjusting knob may be mounted on the controller itself, on the power chassis, the instrument housing, or at any remote location.

The thermistor is a ceramic semiconductor which undergoes a large change in electrical resistance per degree change in temperature. As a result, the thermistor is said to permit control of 1 F or better. Sensing element can be 200 ft or more away from the controller with negligible effect on signal strength. Four control ranges are offered: —100 to 50 F, 0 to 150 F, 100 to 300 F, and 200 to 600 F. Electrical ratings: 115 v, ac, 5 amp non- inductive; and 23 v, ac, 7 amp non-inductive. Fenwal Inc., Ashland, Mass.

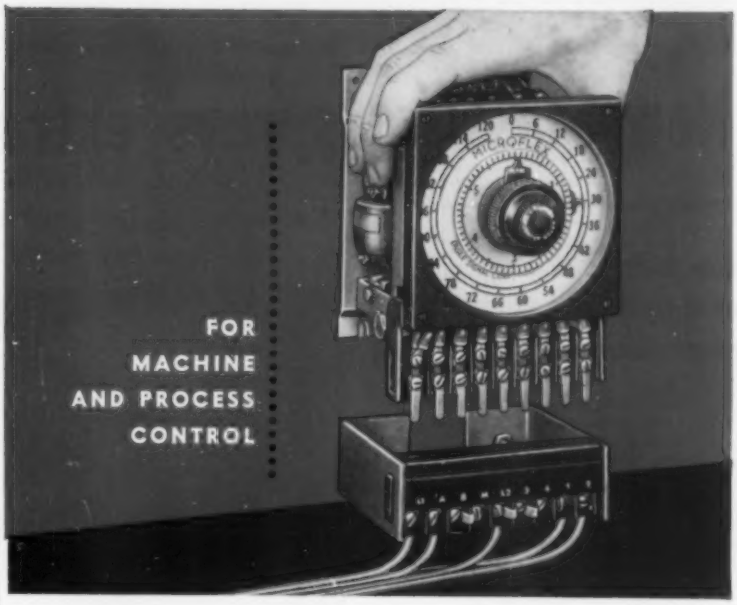
For more information—
Circle 44, inside back cover

Miniature Photo-Electric Cells

The pickup unit measures 1½ x 11/16 x 11/16 in. and is provided with ¼ in. standard pipe threads for mounting. May be used to operate relays when a direct light beam is cut by a passing object, or arranged as shown here to operate on light reflected from

(Continued on page 250)

EAGLE
Microflex Reset Timer



NOW . . . quick plug-in connection!

See that new-design terminal panel? Terminals are all in a row. So you can quickly and easily adapt the Microflex Reset Timer to plug-in connection. Simply use a Microflex Plug-In Kit, available in all accepted variations. You can even rotate the terminal panel for rear connection — (just loosen two screws) — without any rewiring.

Time settings of pinpoint accuracy are possible with the Microflex double dial. Through precision vernier action, one complete turn of the *inner* dial advances the *outer* dial just one division. That's a 20-to-1 ratio, made possible by a patented Microflex threaded axle and pinion. Accuracies are obtainable to 1/60 second. Over 150 timer operating combinations, plus a wide range of long or short time periods. The ideal timer for molding presses, dielectric heating, automatic mixing, die casting machines, machine tools and rubber curing.

Write for FREE AUTOMATION BOOKLET and Bulletin 110.

MAIL COUPON TODAY

EAGLE SIGNAL CORPORATION
Industrial Timers Division, Dept. PE-856
MOLINE, ILLINOIS

Please send FREE AUTOMATION BOOKLET and Bulletin 110 containing complete data on Microflex Reset Timers.

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UNICHROME

News about
COATINGS for METALS
Metallic . . . . . Organic . . . . . Decorative . . . . . Protective

New plastisol sprays extra-thick coating

How to make finishes stick tight to magnesium and aluminum

A primer is only as good as its adhesion. Years have passed since Unichrome Primer AP-10 was first developed as a primer for light metals. Users have had ample experience to confirm what primary producers of the metals have long known about this unique and remarkable primer. The consensus: AP-10 has superior adhesion; its use protects against peeling of the top or finishing coats.

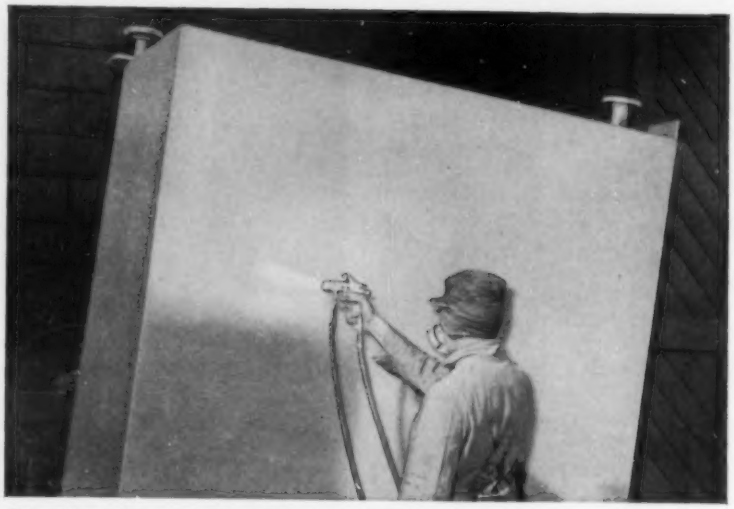
TESTS THAT PROVE ADHESION

When an automotive producer primed magnesium panels with Primer AP-10 and immersed them in water, there was no effect on adhesion even after 500 hours. When an 8 lb. weight dropped 20 ft. on magnesium panels, rupturing them, Primer AP-10 still held tight even at torn edges. When magnesium was first primed with AP-10 and then finished with a top coat, the coating still adhered after 100 hours of salt spray, which was not the case with coatings over the ordinary primers tested.

Unichrome Primer AP-10 enables engineers to specify magnesium and aluminum for products with full confidence that these can be well protected against corrosion and durably finished with lacquers or enamels. It firmly anchors Unichrome lacquers and enamels, or those of other manufacturers. Ask for more details.

METAL & THERMIT
CORPORATION
General Offices: Rahway, New Jersey
Pittsburgh • Atlanta • Detroit
East Chicago • Los Angeles
Metal & Thermit—United Chromium of Canada, Limited, Toronto

Unichrome "Super 5300" Coating builds 60 mil film per coat . . . gives heavy duty corrosion-protection



Tank getting a heavy protective coating with Unichrome Plastisol. Large structural parts of products can likewise be durably finished.

A new and unusual plastisol formulation has been developed by Metal & Thermit, a pioneer in this type of coating. Unichrome "Super 5300" Coating delivers the full solids content of vinyl plastisol right through a spray gun. It enables a coat 60 mils or more to be applied successfully in one application.

THICK AND TOUGH

Amounting to a vinyl "sheet" material, single or multiple coats of this new plastisol can be used to good advantage on many of the products where plastic or rubber sheets are generally specified. Super 5300 Coating also provides a durable, protective finish for large uneven surfaces where only a fluid material can be applied. Good performance is assured for two reasons. (1) With spraying, there are no seams or joints where corrosives might penetrate. (2) Vinyl plastisols have a unique combination of chemical and physical properties.

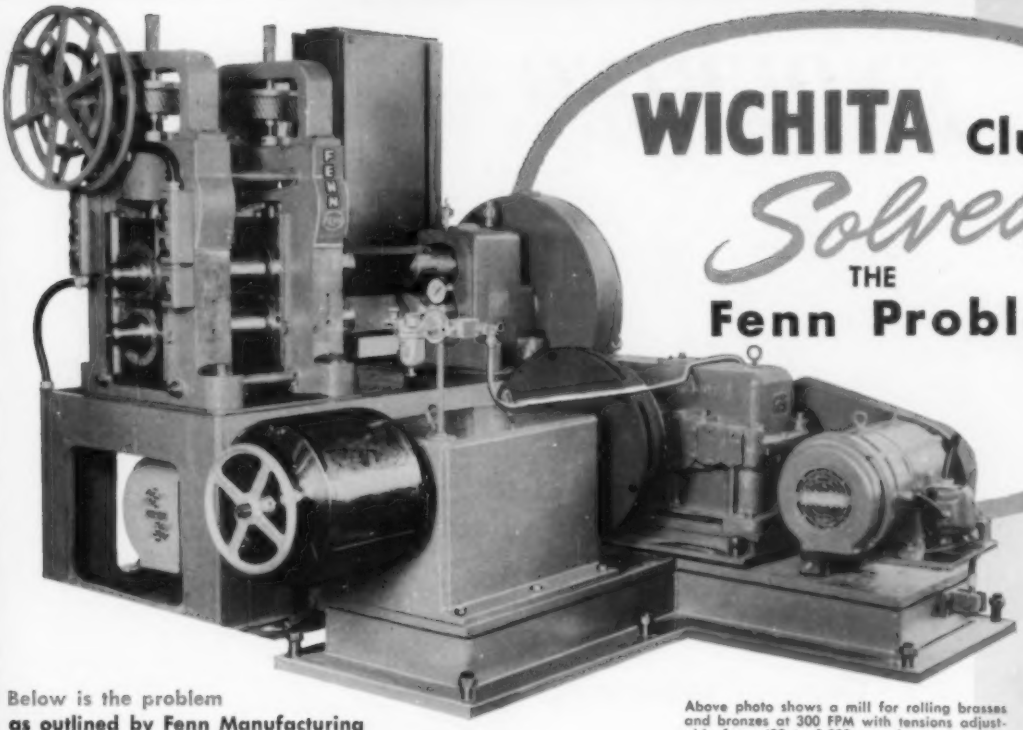
THE ADVANTAGES

Curing quickly at 350° to 365°, Unichrome Plastisols form rugged, resilient coatings with an attractive satin finish. They insulate electrically, absorb impact, don't chip or crack, resist abrasion and erosion, deaden sound.

They give extraordinary protection against a wide range of acids, alkalies, alcohols, salt solutions and moisture. With plastisol protection, ordinary metal parts and products often prove suitable for unusually severe service conditions.

For companies without adequate baking facilities, Metal & Thermit can recommend nearby firms that specialize in applying "Super 5300" Coating. Send for Bulletins that tell more about plastisols.

WICHITA Clutch Solved THE Fenn Problem!



Above photo shows a mill for rolling brasses and bronzes at 300 FPM with tensions adjustable from 400 to 3,000 pounds.

Below is the problem **as outlined by Fenn Manufacturing Company, Newington, Connecticut. They also state how WICHITA Clutches solved their problems.**

An inexpensive machine for rolling and coiling metal onto a drum. It could be done. But these problems arose:

1. The machine must have a clutch that slips at a high rate of speed since most coils have an increase in diameter of 300% to 600% from start to finish.
2. The clutch must constantly slip throughout the run since it is geared-in to run about 20% faster than the mill at maximum drum speed in order to insure correct tension at all itmes. This means slipping seven hours out of every eight.
3. Tension loads on rolled strip are high, representing high torque capacities at the clutch.
4. Successive passes on the strip require less and less tension, meaning a reset of the clutch torque value for each pass.

The WICHITA Clutch Answer . . .

1. They will take higher rates of slippage without excess wear or damage than any other we have tried.
2. They offer us far greater torque values per inch of diameter as well as per pound of weight.
3. They are readily adjustable as to torque settings by merely reducing air pressure at the regulating valve.
4. They embody the only packless air "cylinder" with air-tight construction, durability, and uniformity of performance.

WICHITA Air-Tube Clutches are solving many problems in plants throughout the world . . . with never a replacement having had to be made!

Important Features

- CONTROLLED TORQUE, IMMEDIATE RESPONSE
- EASIER MAINTENANCE
- EXTREMELY LONG LIFE
- NO LUBRICATION
- POSITIVELY VENTILATED FOR COOLER OPERATION

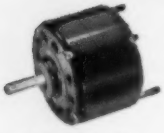
Consult Your Nearest Wichita Engineer for Complete and Detailed Information

WICHITA Clutch COMPANY, INC.
WICHITA FALLS, TEXAS, U.S.A.

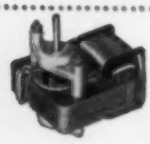
WICHITA DISTRIBUTORS

Brehm-Lahner, Inc., Detroit, Michigan
L. H. Fremont, Cincinnati, Ohio
W. G. Kerr Company, Pittsburgh, Pa.
Smith-Keser & Co. (Main Office), Avon, Conn.
Smith-Keser & Co., Philadelphia 44, Pa.
Smith-Keser & Co., New York, New York
Frank W. Yarline Co., Chicago, Ill.
Power Rig & Equipment Co., Inc., Long Beach, Calif.
Sales Engineering Company, Inc., Salt Lake City 4, Utah
Robert R. King Co., Cleveland, Ohio
John C. Burge, Oklahoma City, Okla.
Dominion Power Press Equipment Ltd., Longacres P. O., Aldershot, Ontario, Canada
Hunt Tool Co., Houston, Texas
Industrial Air Controls Co., Fort Worth, Texas
Allied Transmission Equipment Co., Kansas City 11, Missouri

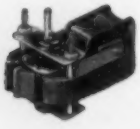
ENDURING
AS AN ELEPHANT!



MODEL B
4-pole, 4-coil shaded pole AC Induction Type



MODEL A
2-pole, shaded pole AC Induction Type



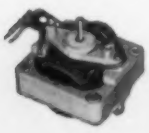
MODEL C
2-pole, shaded pole AC Induction Type

General Industries
FRACTIONAL HP. MOTORS
1/40 HP. to 1/1100 HP.

Dependable power for years of trouble-free performance is a prime factor in every GENERAL INDUSTRIES FRACTIONAL H.P. MOTOR.

■ For over a quarter of a century, original equipment manufacturers have been relying on General Industries 1/40 H.P. to 1/1100 H.P. motors. They've learned by experience that for longer life, ruggedness and quiet operation, GI motors can't be beat! They like General Industries free design consultation service and right-on-the-dot deliveries, too. Whatever your fractional hp. requirements may be, you, too, will find that,— *it pays to rely on GI!*

Write for complete specifications and quantity-price quotations.



MODEL E
4-pole, shaded pole AC Induction Type

MODEL D
4-pole, 4-coil shaded pole AC Induction Type

MODEL O
2-pole Capacitor Reversible Type AC only (for 6, 12, or 24 volts)

MODEL F
2-pole, shaded pole AC Induction Type

THE GENERAL INDUSTRIES CO.
DEPARTMENT GM • ELYRIA, OHIO

a surface. Each type has many applications in counting, positioning, monitoring or sequencing operations. The relay box contains the power relay and associated electronic equipment, together with sensitivity and light adjustments.

Both lead sulfide and cadmium sulfide photo cells are used to meet various conditions. Ess Instrument Co., Dept. D, Bergenfield, N. J.

For more information—
Circle 45, inside back cover

Wheel With Demountable Tire

Demountable wheels and tires are available for medium and regular duty casters made by this company. Wheel plates are 12 gage steel, bolted over a tubular steel hub, equipped with roller bearings. Tires are 1¼ in. thick, and are available made of cushion, neoprene or fibre-filled tread. Albion Industries, Inc., Albion, Mich.

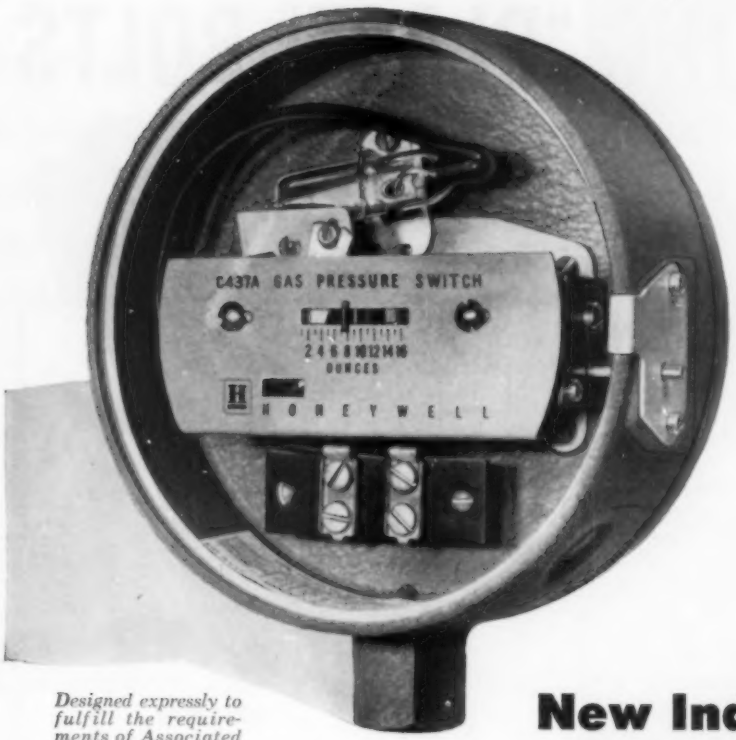
For more information—
Circle 46, inside back cover

Single-Bearing Fhp Motor

Efficiency and the starting and running torques of this motor are said to be increased by the adding of a third area of magnetic flux. This is accomplished with a lamination design new in small diameter motors.

The stator core frame is die cast in one piece. All-angle operation is possible, along with interchangeability to accommodate standard brackets

(Continued on page 254)



Designed expressly to fulfill the requirements of Associated Factory Mutual and Underwriters' Laboratories.

New Industrial Gas Pressure Switch offers 4 exclusive safety features

USE this new Honeywell C437A Industrial Pressure Switch as a safety cutoff on multiple burner gas installations . . . as a pressure controller for hazardous gases . . . or as a differential controller for air or non-hazardous gases. It's simply designed, yet provides complete protection.

The C437A Industrial Gas Pressure Switch has these exclusive safety features:

1. Sealed Pressure Chamber—Should the diaphragm rupture from over pressure or any other cause, gas can't escape into the switch compartment or to the atmosphere. The pressure chamber is fitted with a pipe tap to permit venting to the stack.

2. Protected Settings—All adjustments are inside the case for protection against careless or accidental manipulation. A metal plate on the side of the case must be removed before changes in adjustment can be made.

3. Ever-Visible Switch Position and Control Settings—The entire cover of the pressure switch is a window. Position of the mercury switch and adjustment of the control settings can be determined at a glance.

4. Lockout Mechanism—An optional safety feature, when manual resetting is desired. The lockout mechanism prevents the switch from remaking contact after pressure has once dropped below the setpoint . . . even though pressure returns to normal. The lockout release button is the only adjustment that can be manipulated without removal of the protecting metal plate.

For complete information, call the nearest Honeywell office. A Honeywell sales engineer is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

● **REFERENCE DATA:**

Send for Specification S1011-1 Honeywell Gas Pressure Switch C437A

MINNEAPOLIS **Honeywell**
BROWN INSTRUMENTS
First in Controls

SELF-LOCKING "PLACE" BOLTS

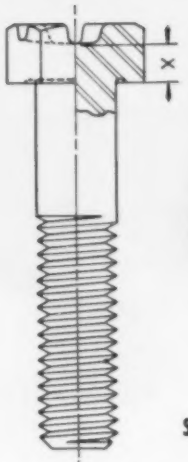
...cut costs...add strength

. . . wherever involuntary loosening or fatigue is a problem!

In some typical automotive and farm equipment applications, for instance, "Place" Bolts are being used as connecting rod bolts, main bearing cap screws, and flywheel bolts.

Here, and wherever a locking bolt may be needed, the Slotted-Type "Place" Bolt offers not only positive locking action but economy and additional strength. It cuts costs because no additional parts or operations are needed. It adds strength because its controlled spring action guards against impact, shock and fatigue failures.

National makes the Slotted-Type "Place" Bolt in carbon or alloy steel, in any of a wide range of sizes. Write us for additional information, including our illustrated folder.



HERE'S HOW SLOTTED-TYPE HEAD LOCKS

The flexible diaphragm formed between slotted segments in the upper face of bolt head and circular recess adjacent to the shank in lower face (section X) acts as controlled spring element when head is properly wrenched against a rigid seat. Diaphragm is reinforced by the continuous-grained segment cold formed between upset slots in upper face.

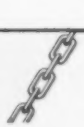
U. S. Patent No. 2543705

THE NATIONAL SCREW & MFG. COMPANY

Cleveland 4, Ohio

Pacific Coast: National Screw & Mfg. Co. of Cal.
3423 South Garfield Ave., Los Angeles 23, Cal.

National PRODUCTS

Fasteners Hodell Chains  Chester Hoists

if your product is

PAINTED
ENAMELED
LACQUERED
LITHOGRAPHED

here's how

WEIRZIN

electrolytic zinc-coated steel

seals it against rust and corrosion

Decorative color finishes adhere to Weirzin Electrolytic Zinc Coated Steel as though they were part of it.

The secret is in Weirzin's ductile zinc coating, which is bonded to the steel so tightly that it remains intact even under the most severe conditions such as high heat or humidity, deep drawing, stamping or forming. Result: no underfilm rust or corrosion.

Thus paint, enamel, lacquer or ink surfaces cannot be attacked from underneath; hence they cannot crack, chip or flake. No wonder Weirzin products look better, last longer, sell faster!

Weirzin is available with or without chemical treatment in coils or cut lengths, in all regular widths and gauges. If you would like specific information on the many ways in which Weirzin may benefit your product, please fill in and mail coupon (right) today.

WEIRTON STEEL COMPANY
WEIRTON, WEST VIRGINIA
a division of
NATIONAL STEEL CORPORATION

WEIRTON STEEL CO., Weirton, West Virginia

I would like to know more about Weirzin.

My product is _____

NAME _____

POSITION _____

COMPANY _____

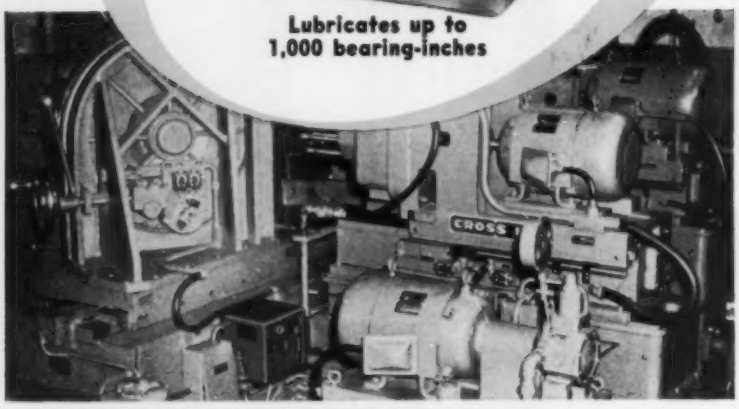
ADDRESS _____

CITY _____ ZONE ____ STATE _____

Latest Advancement in Centralized Lubrication

Norgren 33AF-16 MICRO-FOG Lubricator

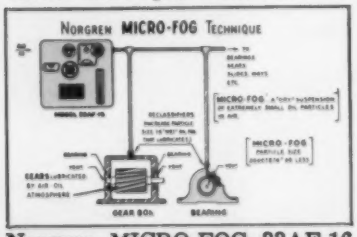
Lubricates up to 1,000 bearing-inches



NORGREN MICRO-FOG Completely Lubricates Cross Multiple Spindle Machine

The Cross Multiple Spindle Machine, above, is used to drill, counterbore, countersink and tap turret hatch covers for military tanks.

On this type of machine, Cross lubricates all six heads and the shuttle shot pin with the new



Norgren MICRO-FOG 33AF-16 Unit. The 33AF-16 automatically creates a finely divided oil fog and uniformly distributes it to the multiple lubrication points. This unit is capable of lubricating up to 1,000 bearing-inches.

Pressure switches and a float-controlled switch — standard parts of the lubricator — automatically actuate alarm lights on the control panel of the Cross machine if air pressure fails, if excessive pressure develops in the oil reservoir, and when the oil supply needs replenishing.

Cross reports the following benefits from using MICRO-FOG: 1. Minimum of bearing wear, resulting from automatic, continuous lubrication with fresh oil. 2. Machines run cooler due to the better heat-dissipating qualities of MICRO-FOG —eliminates heat from fluid friction generated by parts churning in lubricant. 3. Bearing and gear box seals eliminated. 4. Big oil savings over recirculating systems. 5. Less lubricating equipment is required . . . manifolding results in less piping.

Norgren CA Co

3428 So. Elati St., Englewood, Colo.

Without obligation, learn how the Norgren MICRO-FOG 33AF-16 Unit can provide more efficient lubrication and longer machine life. Call your nearby Norgren Representative listed in your telephone directory—or WRITE THE FACTORY FOR BULLETIN 531.

Pioneer and Leader in Oil-Fog Lubrication Since 1930

and special mounts. Rated at 1½ through 16 w, the motor is of four-pole design, 1550 rpm, 115 v, 60 cps, and is also available in odd voltages and frequencies. Redmond Co., Inc., Owosso, Mich.

For more information—
Circle 47, inside back cover

Welded Steel Tubing

Rounds, squares, rectangles, ranging from ⅜ in. OD, 0.028 in. wall up to and including 3 in. OD, 120 in. wall, is now being manufactured. Tubing is made of 1010 or 1020 carbon steel and, if desired, can be sheradized and finished with corrosion-resistant coating. Walker Brothers, Conshohocken, Pa.

For more information—
Circle 48, inside back cover

Extra Soft Rubber

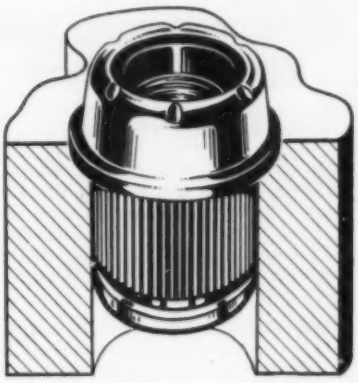
This non-porous rubber can be securely bonded to metal and has a softness of 5 Durometer. It can be used to absorb vibration, dampen sound, or as a gasket; for temperatures up to 200 F. Available in sheets or strips up to 1 in. thick, or molded or bonded to metal parts. Roth Rubber Co., 1860 S. 54 Ave., Chicago 50, Ill.

For more information—
Circle 49, inside back cover

Self-Locking Spline Nut

Designed to be used as self-wrenching fasteners for aircraft and industrial applications in aluminum and magnesium alloys the spline nuts

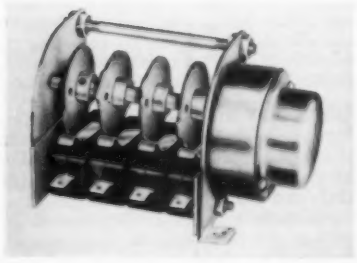
(Continued on page 255)



serve as blind mounting fasteners. A counterbored shank accommodates AN thread length bolts used in aircraft construction. A chamfered pilot on the shank centers the nuts on insertion and assures equal broaching of the installation hole wall by the splines. A chip relief groove immediately behind the pilot allows actual broaching of the hole, minimizes hoop stress in the work and insures proper seating.

A red nylon locking insert is used. Nut is available in cadmium plated steel in 10-32, ¼-28, 5/16-24, ⅜-24, 7/16-20 and ½-20 thread sizes. Shank lengths vary with thread sizes from 0.156 to 0.562 in. Elastic Stop Nut Corp. of America, Union, N. J.

For more information—
Circle 50, inside back cover



Multiple Circuit Timer

This unit is made to individual specifications, using a standard synchronous timing motor and snap-action enclosed switches, rated at 15 amp. 125 v, ac. Available in various switch combinations, the timer is normally made with pre-set factory-adjusted cams and cam settings.

Cam speeds are available in ranges from 1 rev per sec down to 1 rev per

(Continued on page 258)

Norgren

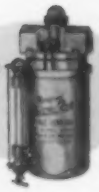
THE MOST COMPLETE LINE FOR AEROSOL BEARING LUBRICATION

1/3 Pt. Oil Capacity

Model	Bearing-inch Rating
30-40-2S	32
30-40-3S	32

½ Pt. Oil Capacity

30-41-2S	32
30-41-3S	32



1 Qt. Oil Capacity

Model	Bearing-inch Rating
S3406-2S	32
S3406-6S	200
S3406-8S	300

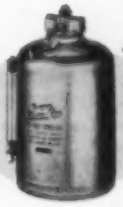
2 Qt. Oil Capacity

Model	Bearing-inch Rating
S3408-2S	32
S3408-6S	200
S3408-8S	300

MICRO-FOG by Norgren

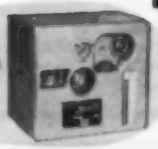
1¾ Gal. Oil Capacity

Model	Bearing-inch Rating
X3400-2S	32
X3400-6S	200
X3400-8S	300



4½ Gal. Oil Capacity

Model	Bearing-inch Rating
Y3400-2S	32
Y3400-6S	200
Y3400-8S	300



2 Gal. Oil Capacity

Model	Bearing-inch Rating
33AH-16	300
33AF-16	1000

Better Lubrication — Automatically, continuously applies finely divided air-borne oil fog.

One Lubricator Per Machine—A lubricator for every size job, 1000 bearing inches and less.

Oil Always Fresh, Clean—No recirculation of contaminated lubricant.

Big Savings in Equipment—Banishes pumps, reservoirs and filters. Fewer oil seals required; less seal maintenance. Manifolding results in equipment savings.

Lower Bearing Temperatures — Dissipates heat better, faster.

Visual Oil Feed — Indicates proper operation of lubricator.

Oil-Saving — Every particle of oil does thorough lubricating job.

C. A. NORGREN CO.
3428 So. Elati St., Englewood, Colorado

Call your nearby Norgren Representative listed in your telephone book—or WRITE FOR NEW CATALOG.

Pioneer and Leader in Oil-Fog Lubrication Since 1930

MORE EFFICIENT DESIGN, IMPORTANT SAVINGS, SIMPLIFIED ASSEMBLY, BETTER APPEARANCE

These are some of the many benefits reported by Design Engineers who have adopted TRU-LAY PUSH-PULLS for remote control operations on literally hundreds of products

Here are typical comments recently received from equipment manufacturers whose machines or implements are equipped with these accurate and dependable remote controls:

Saves Time, Labor and Material
"The use of your flexible Push-Pulls saves us a great deal of time, labor and material. The old linkages frequently required much planning in both engineering and shop which is not required now. On some of our equipment we use Push-Pulls from 10 to 30 feet in length. They operate clutch controls on the Main Power Unit, Feed Conveyors and Delivery Conveyors."

Greater Flexibility of Design
"The principal advantage of Tru-Lay Push-Pulls in our application is that they permit flexibility in locating the control valve in relation to the operator's position."

Cost Less to Install
"Tru-Lay Push-Pulls are easier and less expensive to install than linkages for remote control of power take-off, brake and clutch. Better appearance, too."

Simple and Neat
"For several models of farm tractors, we selected your controls for their simplicity and neatness of application as governor controls."

Solution to Tough Problem
"Can be installed where straight rods are impossible . . . for Remote Control of transmissions, brakes and clutches."

Eliminates Maintenance
"Simple operation and elimination of maintenance problem are the major advantages in using your Push-Pulls."

Reduces Number of Parts
"Your Push-Pulls have eliminated links, radius rods and other lost-motion devices for remote control of hydraulic valves."

Provide ACCURATE Control
"Tru-Lay Push-Pull control cables provide minimum back-lash, even in installations up to 30 feet in length, because the cable is designed to close tolerances with minimum drag and lost motion."

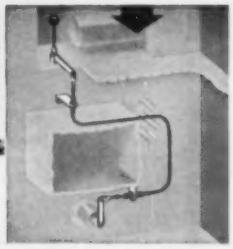
• • •

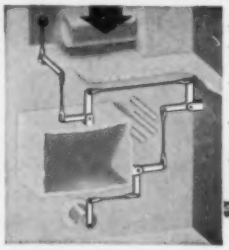
TRU-LAY PUSH-PULLS are "Solid as a rod but *Flexible* as a wire rope." This flexibility makes it possible to snake around obstructions . . . permits the ideal arrangement of all elements of remote controls.

Advantages *of Tru-Lay Push-Pull flexibility and simplicity are pictured below—*

TRU-LAY PUSH-PULL | **MECHANICAL LINKAGES**

Simple
One Moving Part
Life-Time Service
Life-Time Accuracy
Low over-all Cost
Noiseless





Complex
Many Parts
Many Points of Wear
Increasing Back-Lash
Loss of Accuracy
Vibration
Rattles

Construction Equipment and **Farm Implements** provide good examples of the wide-spread use of these accurate, simple and dependable Push-Pulls. On Power Shovels, Winches, Graders, Road Oilers, Dump Trucks, Snow Plows, Engine-driven Pumps, Crushers, Tractors, Combines, Corn Pickers, Corn Row Sprayers, Corn Detasslers, Orchard Sprayers, Power-driven Tree Trimmers, Tobacco Picking Machines and others . . .

TRU-LAY PUSH-PULLS are operating unfailingly for the remote control of Hydraulic and Air Valves, Brakes, Clutches, Transmissions, Throttles, Chokes, Governors, Power Take-Offs, Spray Nozzles, Vent Directional Fins and on many other applications.

ACCO *Our DATA FILE will answer all further questions*

Push-Pull DATA FILE

AUTOMOTIVE and AIRCRAFT DIVISION
AMERICAN CHAIN & CABLE

TRADE MARK

601-E Stephenson Bldg., Detroit 2
2216-E South Garfield Ave., Los Angeles 22 • 929-E Connecticut Ave., Bridgeport 2, Conn.

There is No Worry about Failures or Maintenance Costs with TRU-LAY Push-Pull Remote Controls

Long Life is a matter of record. We have never heard of a Tru-Lay Flexible Push-Pull Control wearing out in normal service. Failures, that sometimes harass users of more complex controls, are eliminated by the use of these simple, positive-action controls.

Dependable Operation of these controls is a certainty, even under the most adverse conditions . . . HOT as jet engines (note: Tru-Lay Push-Pulls are actually performing on hot jet applications) . . . COLD to 70° F below zero . . . SOAKIN' WET . . . ABRASIVE . . . or just plain TOUGH.

Freedom from Trouble is assured because of such features as . . . full protection of the inner, working member by the tough flexible conduit . . . lubrication of the inner, working member *for life* during assembly . . . seals that keep moisture, dust and other foreign matter out of the unit . . . cold swaging of fittings that makes them integral parts of the control unit.

Accuracy is inherent in the basic design of Tru-Lay Push-Pulls. They are precision products, not gadgets.

Capacity ranges from light jobs up to jobs of 1,000 lbs. input. These Push-Pulls will handle jobs 150 feet or more from the control point.

"Solid as a rod, Flexible as a wire rope" aptly describes Tru-Lay Push-Pull Controls. This flexibility provides positive, remote action whether anchorages are fixed or movable . . . it damps out noise and vibration . . . it greatly simplifies installation of controls by reducing the number of working parts and by making it possible to snake around obstructions.

Adaptability to all sorts of mechanical situations explains, in large measure, the wide-spread application of Tru-Lay Push-Pulls. Standard anchorages, fittings and heads have been designed that meet requirements on approximately 80% of the installations. Simple modifications of these standards, or minor changes in your own design, cover almost every special situation. Our engineers have the know-how on such matters, and will work with you.

For Further Information—The DATA FILE pictured at the left contains six booklets and bulletins that will answer any further questions you may have about this versatile and dependable tool. It is quite likely that this material will point the way to a simplified solution of your remote control design problems. Write for a copy.

GET EXTRUDED SHAPES IN BRONZE FOUNDRY ALLOYS

Many of the commonly used foundry bronzes are now being continuously cast in "extruded shapes" in lengths up to 12 feet and in diameters up to 9 inches.

A wide variety of shapes and forms never before available in bronze makes it possible to adapt these useful alloys for applications where casting and machining costs have previously been prohibitive. Shop costs are reduced by using cast rods, tubes and shapes to replace individual castings. Asarco continuous-cast bronzes are ideally suited for machining on automatic screw machines and other high-speed modern equipment.

Practically all of the standard tin-bronze alloys, including lead, zinc and nickel-bearing varieties, are being continuously cast to size. They have consistently better uniformity and machinability for faster work and longer tool life. Physical properties are improved as much as 100 percent over similar alloys cast by other methods.

Get in touch with your nearby Asarco distributor, or write to us directly for complete information on Continuous-cast Bronze.

Continuous-Cast Products Department

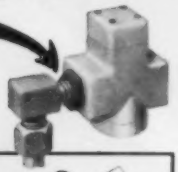
AMERICAN SMELTING AND REFINING COMPANY

Perth Amboy Plant, Barber, New Jersey • Whiting, Indiana
WEST COAST SALES AGENT: Kingwell Bros. Ltd., 457 Minna Street, San Francisco
IN CANADA: Federated Metals Canada, Ltd., Toronto and Montreal

ASARCO

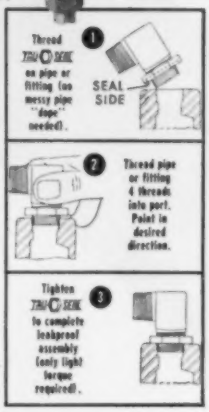
TRU-O-SEAL
TEFLON SEAL
PAT. PENDING

STOPS PIPE THREAD LEAKS instantly!



Prevents future leaks!

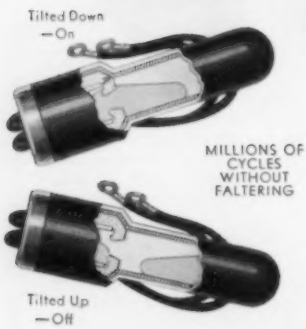
TRU-O-SEAL does away with messy pipe "dope" compounds, eliminates damage caused by overtightening of conventional leaky joints, and is immune to ALL known hydraulic fluids and to steam, air, water, solvents, and practically all gases and chemicals. It withstands temperatures from —100° F. to plus 500° F., saves cost and labor of special or welded fittings, and has been fully field tested and proven by leading manufacturers. Comes in ¼" to 2½" pipe thread sizes.


1
Thread TRU-O-SEAL on pipe or fitting (no messy pipe "dope" needed).
SEAL SIDE
2
Thread pipe or fitting 4 threads into port. Point in desired direction.
3
Tighten TRU-O-SEAL to complete leakproof assembly (only light torque required).

Write for data and prices

TRU-O-SEAL DIVISION
Flick Reedy Corporation
2002-04 N. Hawthorne Melrose Park, Ill.
"Miller Fluid Power" is also a Div. of Flick-Reedy Corp.

Durakool Tilt Switches are the Life of your Automatic Controls



This steel-clad Durakool mercury tilt switch has unique construction features that deliver years of trouble-free performance on the most difficult assignments you can find. Operating under sealed-in, pressurized hydrogen gas, it takes 24 hours, fast cycling schedules in stride. 7 sizes, 1 to 65 amperes. Send for Bulletin 525.

See telephone directory for local distributor, or write.
DURAKOOL, INC.
ELKHART, INDIANA, U.S.A.···700 WESTON RD., TORONTO 9, CANADA

Durakool ALL-STEEL MERCURY *Switches*

month. Unit pictured is approximately 3 x 2 x 4 in. long. Bristol Motor Div., Vocaline Co. of America, Inc., Old Saybrook, Conn.

For more information—
Circle 51, inside back cover

Edgewise Panel Meter

Full-scale meter sensitivity of ½ microamp has been attained in a panel meter for voltage, current and resistance measurements. These instruments use a bifilar suspension movement, with accuracy up to 0.25 per cent. Greibach Instruments Corp., Metuchen, N. J.

For more information—
Circle 52, inside back cover

Detachable Coupler For Fluid Lines

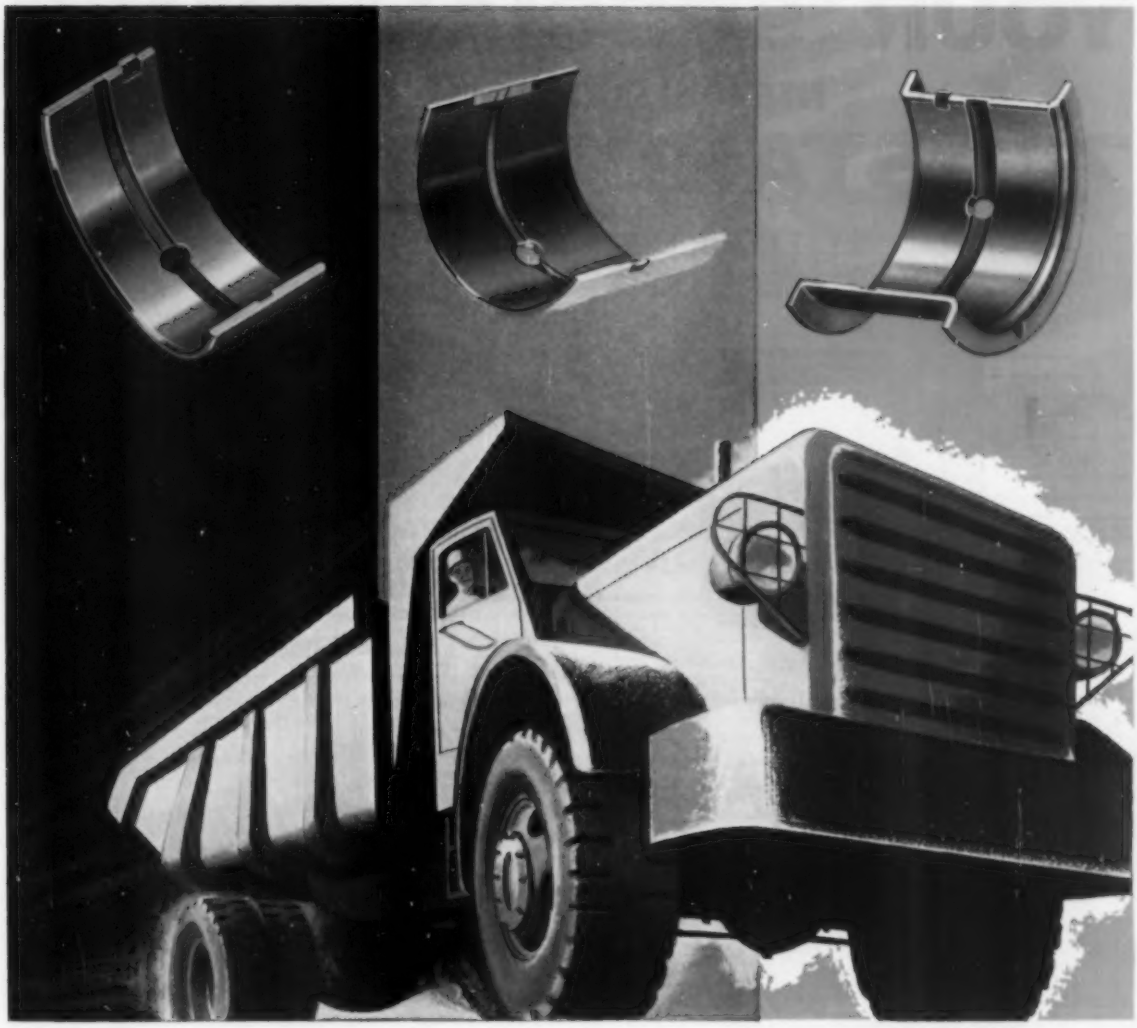
These couplers provide automatic plug-in snap-out for air, oil or grease lines. Can be used directly with reciprocating air tools without lead hoses. Foster Mfg. Co., Inc., 3850 Gravois, St. Louis 18, Mo.

For more information—
Circle 53, inside back cover

Cooling and Lubricating System

Designed for tool room equipment and single point metal cutting and stamping operations, this mist cooling device refrigerates coolant and lubricates the machining of metals, plastics and other materials. A special coolant is pressurized and forced through the nozzle. As the fluid is ejected from the nozzle it flows over the outside of the liquid control needle. Through the center of this needle, a jet of high velocity air is

(Continued on page 262)



RESEARCH • DESIGN • METALLURGY • PRECISION MANUFACTURING

High-speed, high-temperature, heavy-duty engines are a real test of engine bearing performance. To meet these requirements calls for watch-like precision in bearing production, with continuous test-and-inspection at every major step in manufacture. With over half a century's specialization in sleeve bearing production, by the thousand or the million, we are equipped to meet these modern requirements.

FEDERAL Mogul

SINCE 1899

FEDERAL-MOGUL DIVISION

FEDERAL-MOGUL-BOWER BEARINGS, INC., 11043 SHOEMAKER, DETROIT 13, MICHIGAN

YOUR "SPECIAL" TIMER
may be one of our
721 STANDARD UNITS!

We have 20 years of experience in developing new timers to meet our customers' widely varying requirements. Our Engineering Department not only originates new designs, but also develops modifications for that purpose. That's why most requests for special timers can be filled without delay—by one of the 721 combinations we've developed so far from our 17 basic types of timers. But if we don't have what you want on hand, we'll welcome the chance to design and make it for you! And quickly too!

We manufacture a complete line of timers in these 4 broad classifications:

INTERVAL TIMERS • TIME DELAY TIMERS
RE-CYCLING TIMERS • RUNNING TIME METERS

Our large stock assures you of rapid deliveries—even when we have to create a brand new timer for your special needs. Ask us first—you may save yourself much lost motion... and your inquiry will receive prompt attention.

Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION

1415 McCARTER HIGHWAY, NEWARK 4, N. J.

FOR ORIGINAL EQUIPMENT MANUFACTURERS IN ALL INDUSTRIES

Fabricated to exact customer specifications from Spaulding's own widely adaptable basic materials, these parts and components are typical of the countless varieties that Spaulding supplies to original equipment manufacturers in almost every conceivable industry.

Contact the Spaulding Sales Office in your area to investigate the amazing possibilities which Spaulding's Vulcanized Fibre, Laminated Plastics and other materials hold for the products **you** manufacture or design. It's likely you'll find that Spaulding can help you cut cost and improve quality in your original equipment production.

THE PROPERTIES OF SPAULDING MATERIALS INCLUDE Great mechanical strength, extremely light weight, durability, chemical inertness, excellent machinery qualities, arc resistance, deionizing ability and low loss electrical insulation.

WE MAKE AND FABRICATE

VULCANIZED FIBRE: In sheets, rods, tubes and fabricated parts.

ARMITE: Thin Insulation (Fish Paper) in sheets, rolls, coils and fabricated parts.

SPAULDITE: (Laminated Thermosetting Plastic) in sheets, rods, tubes and fabricated parts.

SPAULDO: Motor Insulation in sheets, rolls, coil, slot cells and other fabricated parts.

SPAULDING FIBRE BOARD: In sheets and fabricated parts.

SPAULDING T BOARD: A superior Transformer Board in sheets and fabricated parts.

MATERIALS HANDLING EQUIPMENT: Factory Trucks, Boxes, Barrels, Trays, etc.

SPAULDING FABRICATING FACILITIES: Spaulding's fabricating facilities for these products are unsurpassed the world over. You can save time and money by letting us do your fabrication. We'll be glad to quote on specific jobs without obligation.

SPAULDING BRANCH SALES OFFICES

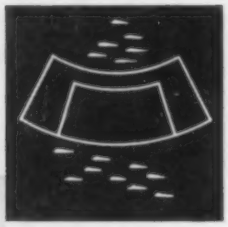
Baltimore 18, Md., 123 West 22nd St.
Boston 16, Mass., 585 Boylston St.
Boston Area:
Wellesley Hills 82, Mass., 44 Washington St.
Bridgeport 5, Conn., 2889 Fairfield Ave.
Camden 1, N. J., 227 South Sixth St.
Chicago 25, Ill., 4770 Lincoln Ave.
Chicago 38, Ill., 5604 West 63rd St.
Cleveland 14, Ohio, 2108 Payne Ave.
Cleveland 16, Ohio, 19035 Detroit Rd., Rocky River
Dayton 2, Ohio, 136 So. Ludlow St.
Detroit 1, Mich., 4612 Woodward Ave.
Fort Wayne 6, Ind., 2301 Fairfield Ave.
Lansing 10, Mich., 2021 South Cedar St.
Woodhaven 21, L. I., N. Y., 90-34 Jamaica Ave.
Milwaukee 8, Wisc., 3329 West Vliet St.
New York 55, N. Y., 384 East 149th St.
St. Louis 5, Mo., 7247 Olive Street Road
St. Louis 17, Mo., 1500 Big Bend Blvd.
Tonawanda, N. Y., 310 Wheeler St.
Westfield, N. J. (Newark Area), 101 Central Ave.
Berkeley 10, Calif., 2221 Fourth St.
Los Angeles 15, Calif., 1325 San Julian St.
Toronto 18, Ont., A. A. Andersen & Co., Ltd., P. O. Box 92

SPAULDING FIBRE CO., INC. 310 Wheeler Street, Tonawanda, N. Y.

STACKPOLE

CARBON-GRAPHITE *Materials and Components*

Solve problems of friction, temperature, corrosion, arcing . . . and many others



LONG-WEAR FRICTION SEGMENTS

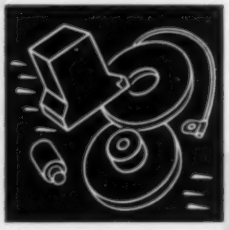
As a brake material, or in friction drives working against steel, Stackpole friction segments provide maximum life and efficiency—even under pressure changes and elevated temperatures.

ELECTRONIC TUBE ANODES

Non-warping, long-life Stackpole anodes assure lower temperature operation, uniform characteristics and important cost savings for electronic tubes of many different types.

NON-WELDING or FILMING ARC-RESISTANT CONTACTS

Stackpole silver plus refractory material contacts spell top efficiency in many electrical applications where ordinary contacts cause trouble because of arcing, welding or filming. Send details of application for recommendation.

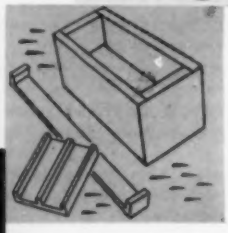


LOW-FRICTION BEARINGS

Stackpole carbon-graphite bearings are readily formed to close tolerances. Composition and shape can readily be designed for maximum efficiency on specific applications. New high temperature types now available.

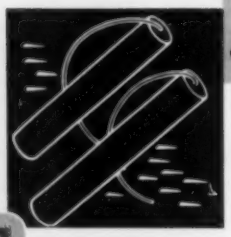
BRAZING BOATS *and* TRAYS

Practically any shape or size. Withstand extreme thermal shock . . . permit quick cooling. Alloys do not stick to trays in brazing.



BETTER RUST PROTECTION

For pipe lines, marine structures, ship hulls, tanks, structural footings . . . and other buried or immersed metal objects. Stackpole Cathodic Protection Ground Rods can be obtained from Corrosion Control Inc., Tulsa, Okla.



STACKPOLE CARBON COMPANY

St. Marys, Pa.

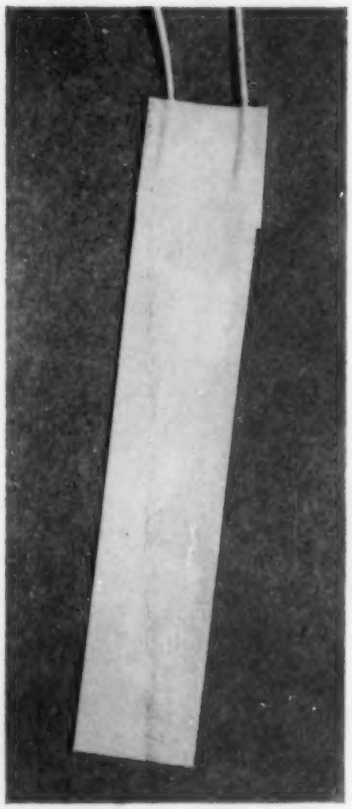
OTHER STACKPOLE PRODUCTS INCLUDE: BRUSHES for all rotating electrical equipment • metal powder ELECTRICAL CONTACTS • CARBON DISCS (piles) • CHEMICAL ANODES • SEAL RINGS • CLUTCH RINGS • PUMP VANES • MOLDS and DIES • WELDING CARBONS RESISTANCE WELDING and BRAZING TIPS • POROUS CARBON • PURE CARBON SPECTROGRAPHITE • ELECTRIC FURNACE HEATING ELEMENTS • WATER HEATER and PASTEURIZATION ELECTRODES . . . and many more.

discharged, penetrating the liquid from the inside.

This action produces liquid suspension in the air. Upon expansion in the atmosphere, a flow of coolant said to average 25 F lower than compressed air temperature is directed on the cutting tool and material being worked.

Complete units are currently available in 1, 3 and 6 gal sizes. All models feature single or dual controls for both liquid and air. The units are equipped with pressurized tanks tested at 150 psi, quick bleed-back air pressure control valves, and full tank length liquid level gauges. Frisch Corp., 1400 W. Wabansia, Chicago 22, Ill.

For more information—
Circle 54, inside back cover



Film-Type Heating Element

An electrical resistive film heater is said to be unaffected by environmental conditions or moisture and to be capable of continuous operation at

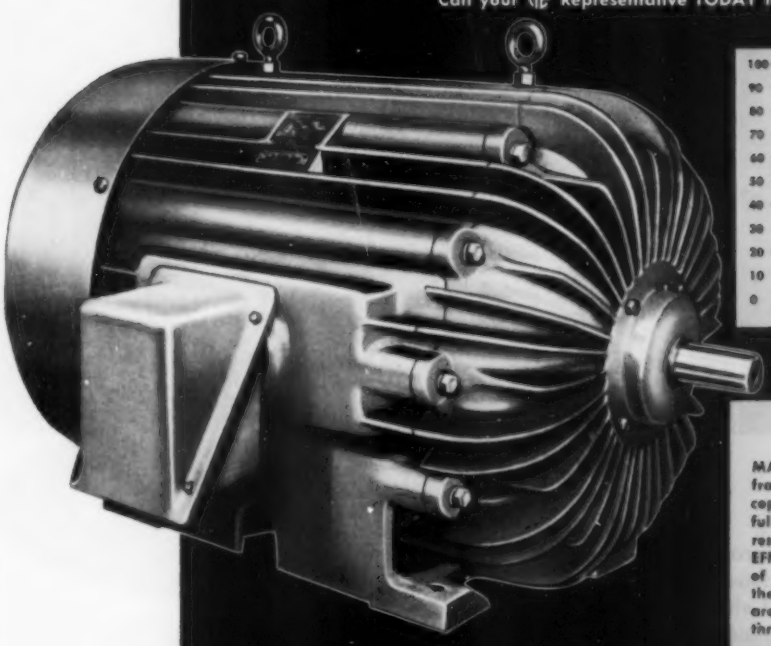
(Continued on page 266)

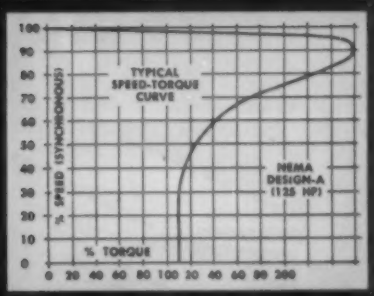
WHY MARATHON ?

• **EXPERIENCE OF PROVEN PERFORMANCE . . . OVER HALF A CENTURY**
There is no substitute for the reliability of proven ME performance. Top names of the Nation's Industry have proven ME performance in ENGINEERING . . . DESIGNING . . . PRODUCING QUALITY PRODUCTS.

• **VERSATILITY WITH A WIDE RANGE OF DESIGN**
MOTORS 1/20 thru 2500 HP . . . GENERATORS ½ thru 2000 KW . . . Single Phase, Polyphase, Direct Current . . . Standard or Special . . . Marathon Electric can design to meet your special specifications.

• **SERVICE THROUGHOUT THE NATION**
MARATHON ELECTRIC has a DISTRICT OFFICE or Representative near you. Call your ME Representative TODAY to help solve your motor problem.





EXPLOSION PROOF MOTORS

MARATHON ELECTRIC'S familiar ribbed frame construction has already been often copied but never duplicated. This carefully developed rib design formula has resulted in the COOLEST, CLEANEST, MOST EFFICIENT, and MOST COMPLETE RANGE of EXPLOSION PROOF MOTORS to carry the Underwriters' Laboratories Label. They are available in NEMA frame from 56 thru 680 series, from 1/12 thru 250 HP.

All ME Explosion Proof Motors Carry Underwriters' Laboratories, Inc. INSPECTED Label in 1/12 HP Through 250 HP Ratings

SINCE 1913

MARATHON ELECTRIC

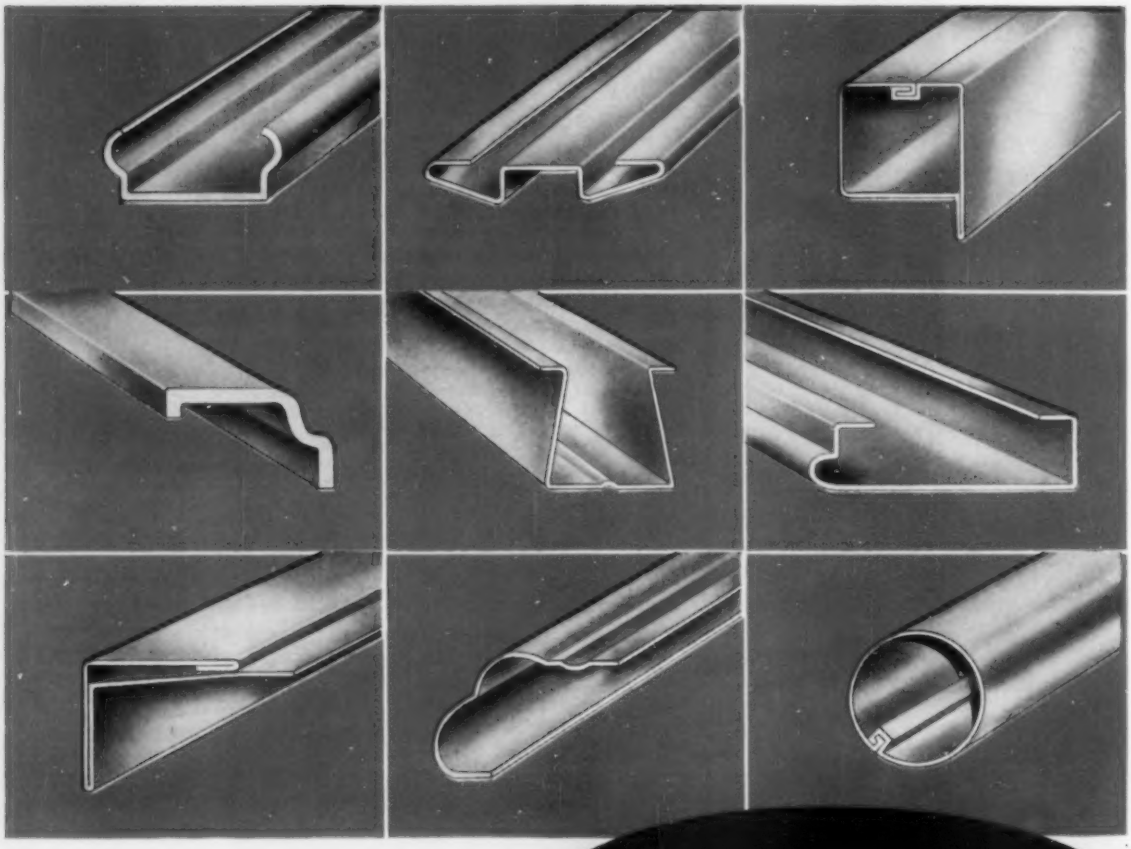
HOME OFFICE AND FACTORY, WAUSAU, WIS. FACTORIES AT ERIE, PA. AND EARLVILLE, ILL.

SALES OFFICES IN PRINCIPAL CITIES

Write or Wire SPADE 10 for further Information

INCREASE YOUR PRODUCTION WITH ROLL FORMED SHAPES

. . . carbon, galvanized and stainless steel; aluminum, copper, brass, zinc and clad metals delivered accurately punched, notched, bent and cut for final assembly.



ROLL FORMED PRODUCTS COMPANY

Let us help you increase production and lower costs. It can be done simply by changing to Roll Formed shapes which are formed, notched, pierced and cut to length in one continuous operation. We meet your most exacting specifications. Our accuracy cuts valuable man-hours from your final assembly costs. We're equipped to deliver Roll Formed shapes up to .125" thickness on schedule by the hundreds of thousands. Send your sketch or blueprints for prompt quotation. For details on our production facilities and techniques, ask for Catalog No. 1555. Do it today!

MAIN OFFICE AND PLANT • 3756 OAKWOOD AVE. • YOUNGSTOWN, OHIO

CORNING GLASS BULLETIN

FOR PRODUCT DESIGNERS

Gadolinium and all that

Out Chicago way, at Lindsay Chemical Company, they're busy exchanging ions. Purpose? Obtaining commercial quantities of such rare earths as samarium, europium, gadolinium, terbium, dysprosium, erbium, thulium, ytterbium, yttrium, lutetium, and holmium.

At the heart of Lindsay's purposeful and plentiful piping and plumbing, you'll find a number of PYREX brand glass columns.

Glass because it provides complete visual control. PYREX brand glass No. 7740 because (as Lindsay people tell) it provides an absolute minimum (not *minimium*) of contamination and a flexible system that permits ready adjustment.

(Commercial: Chemists are only one breed of practical-minded men who have turned to a PYREX brand glass in one form or another to solve a particularly challenging materials problem.)

Facts: PYREX brand glass No. 7740 is a borosilicate glass having low alkali content and unusual capacity to withstand the ravaging attacks of most acids, and environments like steam under pressure.

This glass also displays a commendable capacity to cope with thermal stress, exhibiting a linear coefficient of expansion of 32.5 x 10^{-7} per °C. between 0° and 300° C.

It's a clear glass and can be handled as blown or pressed ware; also readily made into plates and panels, tubing and rod.

In one product development, even *one-piece molding* of a quite complex shape was profitably accomplished for a manufacturer of dentists' sterilizer trays.

PYREX brand glasses (including a number of interesting variations similar to 7740) offer an unusual challenge to those concerned with the successful and profitable solution of materials problems.

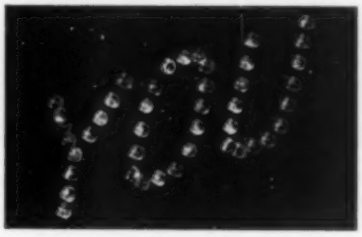
Some hints about the PYREX brand and other glasses by Corning *in use* can be gleaned from Bulletin IZ-1, "Glass . . . its increasing importance in product design." Free with the coupon.

On getting one's bearings

Glittering and glinting against a black velvet backdrop are these ¾-inch high letters spelling Y O U.

Forming this simple word took 43 jewel bearings, those minuscule mechanisms that contribute so much to the performance accuracy of many kinds of instruments.

These particular "jewel" bearings are made of glass, a *not* uncommon practice. Bearings made of glass get their start as cane—cane that we hold in manufacturing to a diameter tolerance of .0235". (Cane, by way of elucidation, is glass



industry jargon for what you probably call solid rod.)

At any rate, spaghetti-like strands of this cane are supplied by us to makers of precision instruments. Our job is purveying preliminary precision; we do *not* make the finished bearings.

Still, the glass itself might be of interest to you, since along with close tolerances, it possesses quite astounding surface hardness.

Specific values are somewhat difficult to spell out because of the conflicting methods extant for comparing various materials.

If you wish to pursue this point further, however, we'll happily supply you with all the details.

As a matter of record, hardness is just one of the many useful characteristics available in the glasses that Corning engineers today.

From amongst the thousands of formulas developed by Corning research, you'll find glasses that selectively transmit or absorb almost every form of radiant energy; glasses lighter than aluminum or heavier than concrete; ribbon-thin or brickwall-thick; sensitive or indifferent to temperature. In fact, you name the *combination* of characteristics desired and there's probably already a glass to fill the bill.

Of necessity this sweeping survey only begins to tell the story of glass as a basic material of design and construction.

For more substantial fare, we recommend one or more of the following: Bulletin B-83: "Properties of Selected Commercial Glassware," a slender but solid compendium of data; "Glass and You," a well-illustrated introduction to the working wonders of glass; or, "New Industrial Uses for Glass," a reprint of a survey article that appeared in *Product Engineering* last summer. Using the coupon will expedite matters.

Wanted: Men with materials problems

If you have a stubborn materials problem that might find its answer in glass, let's get together.

In searching for the answer, you may find it profitable to put to your use our research, application, design and production experience . . . *plus* facilities.

Time and time again we've been pleasantly surprised by the ingeniousness of people who have hit upon some new use for glass—a new use that we've helped put into practical and profitable shape.

Maybe you're next. Write, wire, or call.

Corning means research in Glass

CORNING GLASS WORKS, 51-8 Crystal Street, Corning, N.Y.

Please send me the following material: Bulletin IZ-1, "Glass . . . its increasing importance in product design" ☐; Illustrated Bulletin, "Glass and You" ☐; Bulletin B-83, "Properties of Selected Commercial Glassware" ☐; *Product Engineering* reprint ☐.

Name_____ Title_____

Company_____

Street_____

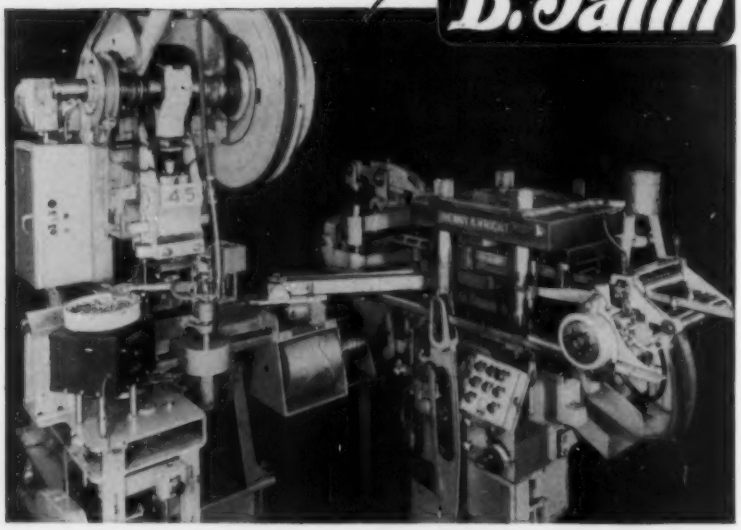
City_____ Zone_____ State_____

2 PRESSES . . . 1 PROGRESSIVE DIE . . . 1 STIPPLING DIE . . . ENGINEERING INGENUITY . . . SPECIAL MACHINERY . . . SPECIAL ELECTRICAL COMPONENTS . . .

produce

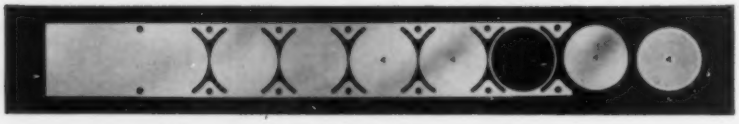
AUTOMATION

by **B. Jahn**



Here's true automation — 100% automatic production, 100% B. Jahn built, that transforms .025" aluminum into precise meter components 3⅜" in diameter — each with 720 teeth .009" deep — without human hands, human error!

Equipped with B. Jahn progressive die, one 60 ton press was linked by a chain drive to a 45 ton press incorporating a stippling die.



Progressive die, ground all over to guarantee greater accuracy, longer service, less downtime, pierces and blanks intricate discs.

Conveyor system feeds disc into air-operated vacuum arm that positions piece in B. Jahn stippling die. Another arm removes stippled piece and places it on stacking unit.

Completed discs, at the rate of 30 per minute, are automatically stacked and spaced on spindle. Here's true AUTOMATION, true production economy!

Get Full Details On This Astounding "No Hands . . . No Delay . . . No Error" Automation Application — Send Today for the Big New B. Jahn Brochure.

B. Jahn

THE B. JAHN MANUFACTURING COMPANY, NEW BRITAIN, CONNECTICUT

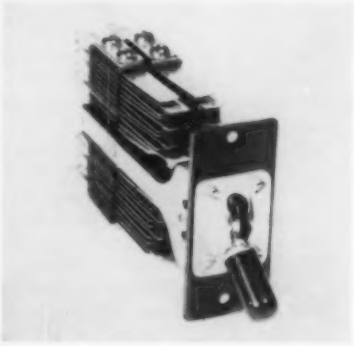
600 F. Operation to wattage densities of 40 w per sq in. may be thermostatically controlled. Thermatic Company, Box 585, Great Neck, N. Y.

For more information—
Circle 55, inside back cover

Primer for Galvanized Metals

Manufacturer claims this coating will prevent paints, lacquer, enamel or other air-drying coatings from peeling off the surfaces of galvanized metal. Colorless, non-flammable and odorless, the primer may be applied by brush, or a cloth saturated in the solution. It may also be used as a dipping bath. Solfo Paint Mfg. Co., Trenton 3, N. J.

For more information—
Circle 56, inside back cover



Lever Switch With Safety Lock

The locking device snaps into place when the lever is moved to either operated position or neutral. The lever must then be pushed inward to release the lock before it can be moved out of a position. Donald P. Mossman, Inc., Brewster, N. Y.

For more information—
Circle 57, inside back cover

Pilot-Operated Control Valve

A complete line of solenoid pilot-operated control valves, built to JIC standards, is announced by Valvair Corporation. Meeting JIC pneumatic standards, these valves have solenoid enclosures sealed to prevent entrance

(Continued on page 270)

CHAIN NEWS!

NEW "*Electrolized*" ATLAS ROLLER CHAIN

NON-CORROSIVE . . . COSTS 40% LESS

Here's a revolutionary new roller chain developed to meet the most exacting requirements of the chemical, food, bottling and other industries where corrosion is an important factor. Stands the most severe torture tests . . . meets and beats A.S.C. specifications . . . yet costs far less.

STAINPROOF, CORROSIVE RESISTANT Electrolized parts came through severe salt spray corrosion tests with flying colors . . . last as much as 800% longer.

HIGHER TENSILE STRENGTH Has same tensile strength as alloy steel chain . . . much higher than bronze or stainless steel chain.

WEARS LONGER Friction of parts has been reduced by more than 50% . . . wear cut to a minimum . . . chain life greatly increased.

LOWER PRICE Atlas Electrolized Roller Chain is as much as 40% lower in price than any other corrosion resistant chain now on the market.

TESTED AND PROVED!

This new Atlas Electrolized Chain has been torture-tested on installations and tested in laboratories. It has successfully resisted the action of salts, chemicals, detergents, acids, caustics, alkalis and many other corrosive elements.

Get the facts on this new chain for use where corrosion tensile strength and long wear are important . . . as well as low cost. Write Atlas Chain and Manufacturing Company, West Pittston, Penna. Act now and

SEND THIS COUPON FOR SAMPLE

Please send sample of Atlas Electrolized Chain and data to—

NAME_____ TITLE

COMPANY_____

ADDRESS_____

Same filter capacity in 1/5th the space!

That's the advantage Cuno's new, 40-micron SUPER Auto-Klean has over a replaceable-cartridge-type filter!

. . . and you can clean this 40-micron filter simply by turning the handle.

Five to six times smaller in volume than comparable cartridge-type filters of equal capacity, Cuno's new SUPER Auto-Klean® is easy to integrate into new or existing engines, machine tools, or industrial machinery.

It provides positive protection against solid particles larger than 40 microns (actually 0.0015 in.) in lubricating oil, hydraulic fluid, coolant, or other industrial fluids. Here are other features it offers the machine designer:

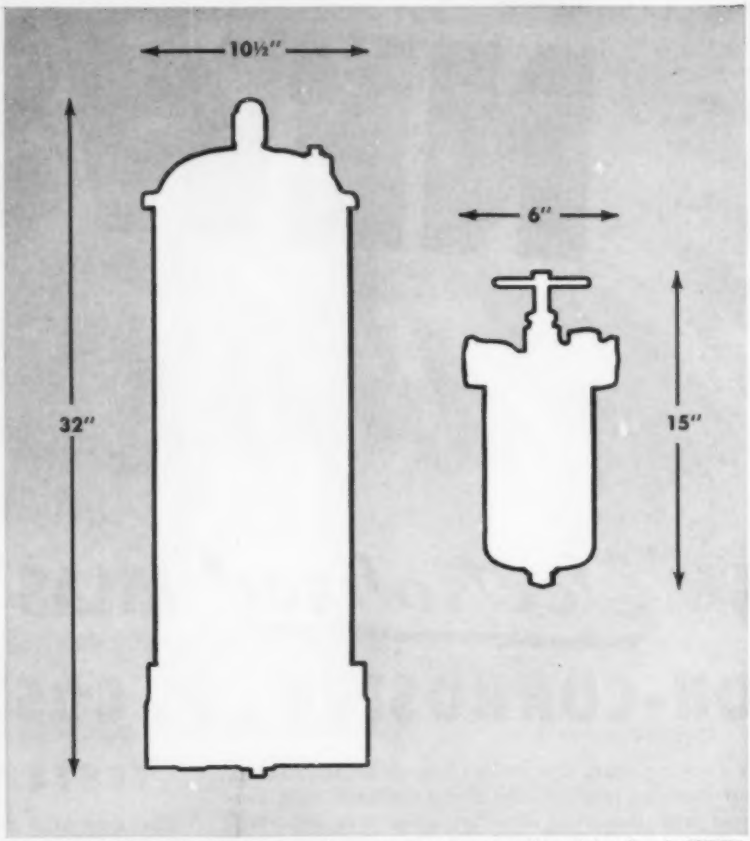
1. Easy cleaning. Just turn the handle—by hand or continuously with motor drive. No interruptions for cleaning.

2. No cartridge changes. Ends operating costs if you've been using cartridge type filters.

3. Low pressure drop, no pressure drop build-up. An 8- by 2¼-in. SUPER Auto-Klean element filters 30 gpm of 200 SSU oil with only 3 psi pressure drop—up to 75% more with slightly higher pressure.

4. Easy to build into new equipment. Standard housings and types available for a variety of mounting designs—in-line housings, flange mounting with external or internal piping. Mounts in any position in sump or reservoir.

5. Easy to install in old equipment. Fits existing Auto-Klean housings. You can easily replace most 2¼-in. diameter elements with SUPER Auto-Klean for finer, more effective filtration.



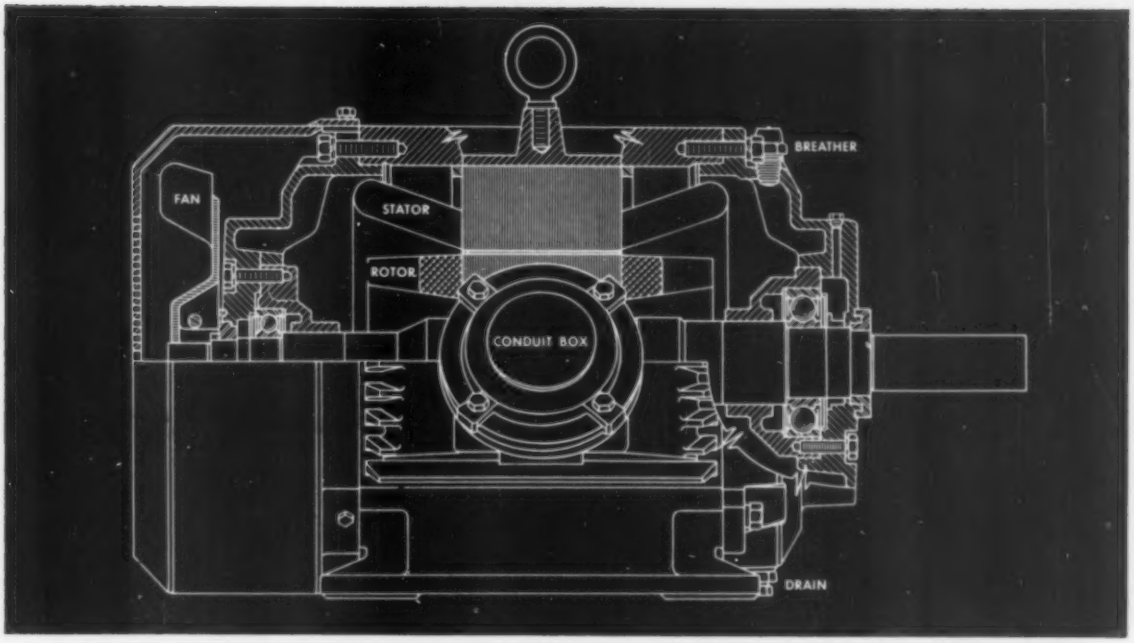
FIVE TO SIX TIMES SMALLER than equal-capacity cartridge-type filter *(left)*, Cuno's SUPER Auto-Klean *(right)* is ideal for micronic filtration of lube, fuel, hydraulic fluid, coolant in compact engines or machine tools.

Get complete information on this latest and best filter for *your* machine design. We're saving a free copy of SUPER Auto-Klean Catalog No. SAK-057 for you. Write for it today to Cuno Engineering Corporation, 20-8 South Vine Street, Meriden, Connecticut. 5.12

CUNO **ENGINEERED FILTRATION**

REMOVES MORE SIZES OF SOLIDS FROM MORE KINDS OF FLUIDS

AUTO-KLEAN (edge-type) • MICRO-KLEAN (fibre cartridge) • FLO-KLEAN (wire-wound) • PORO-KLEAN (porous stainless steel)



THIS MOTOR CAN CUT YOUR HAZARDOUS ATMOSPHERE INSURANCE COST

Insuring facilities with electric motors in hazardous atmospheres is generally expensive or impossible without special motors. Reliance has developed a completely new, Underwriters' approved motor design, called explosion-proof, for hazardous locations. In fact this is the only motor design that meets all qualifications for classes I, group D and class II, groups E, F and G without requiring modification.

This new motor incorporates all of the outstanding features of the standard Reliance Totally-Protected Motor. In addition, all Reliance Explosion-Proof Motors are built to corrosion-proof standards.

If you would like to have more information on what qualifies a motor for hazardous atmospheres, write for our new Explosion-Proof Motor Bulletin No. B-2409.

B-1528

NATIONAL ELECTRICAL CODE CLASSES OF HAZARDOUS LOCATIONS

CLASS I —Those in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures.

Group D —Atmospheres containing gasoline, hexane, naphtha, benzine, butane, propane, alcohols, acetone, benzol, lacquer solvent vapors, or natural gas.

CLASS II—Those which are hazardous because of the presence of combustible dust.

Group E —Atmospheres containing dust of aluminum, magnesium, or their commercial alloys.

Group F —Atmospheres containing carbon black, coal or coke dust.

Group G—Atmospheres containing flour, starch or grain dust.

RELIANCE *Totally-Protected* MOTORS

RELIANCE ELECTRIC AND ENGINEERING CO.

DEPT. 308A, CLEVELAND 10, OHIO • CANADIAN DIVISION: WELLAND, ONTARIO

Sales Offices and Distributors in Principal Cities

look at these advantages of

IRIDITE® FINISHES

for

CORROSION-RESISTANCE, PAINT BASE on ALUMINUM and MAGNESIUM

TYPICAL APPLICATIONS

Aircraft and Missile Parts

Automobile Hardware

Outdoor Furniture

Communications Equipment

Marine Equipment

EASE OF USE—Iridite is a simple chromate conversion treatment. Fast, easy, economical. You just dip, brush or spray it on the part at room temperature. No special equipment. No specially trained personnel.

OUTSTANDING PERFORMANCE—Forms a film that is an integral part of the metal itself. Can't flake, chip or peel. Takes paint firmly on initial application, and the bond lasts. Even protects areas scratched in use.

LOWEST COST—You have only minimum equipment cost, no special racks, high speed operation, lower overall handling costs.

CHOICE OF APPEARANCE—Clear coatings that retain metallic lustre to dark, maximum protection coatings. A variety of colors is available by dyeing.

IRIDITE # 14 and # 14-2 (Al-Coat) for ALUMINUM

Two specially formulated finishes that give you maximum latitude in aluminum treatment. Both provide excellent corrosion protection and paint base. Iridite #14-2 is an improved product that allows greater flexibility in operation and coating thickness and produces the optimum in corrosion protection.

Either coating provides corrosion resistance superior even to complicated electrolytic treatments in a fraction of the time. These coatings also offer many other valuable characteristics: they have low electrical resistance, they aid in arc-welding, provide a good base for bonding compounds, have no effect on the dimensional stability of close-tolerance parts. Final appearances ranging from clear through yellow iridescence to full brown can be obtained. By dyeing, you can produce red, green, blue, orange or yellow finishes.

IRIDITE # 15 for MAGNESIUM

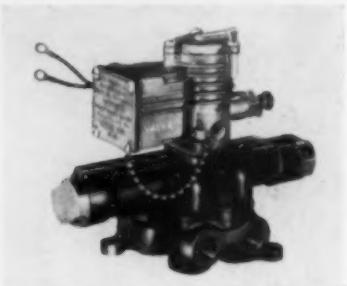
Produces a protective, paint base film with corrosion resistance at least equal to that obtained from long, high-temperature dichromate treatments in a fraction of the time and at room temperature. The appearance of the coating can be varied from light brown to dark brown and black.

APPROVED UNDER GOVERNMENT AND INDUSTRIAL SPECIFICATIONS

SEE FOR YOURSELF WHAT IRIDITE CAN DO . . . SEND SAMPLE PARTS FOR FREE PROCESSING. Look at the results, test the protection, evaluate the savings. Also write for handy Reference File of the most complete data published on chromate conversion coatings. Or, for immediate information, call your Allied Field Engineer. He's listed under "Plating Supplies" in your classified phone book.

ALLIED RESEARCH PRODUCTS
INCORPORATED
4004-06 E. MONUMENT STREET • BALTIMORE 5, MD.

Manufacturers of Iridite Finishes for Corrosion Protection and Paint Systems on Non-Ferrous Metals; ARP Plating Chemicals.
West Coast Licensee—L. H. Butcher Co.



of splashing liquids or airborne contaminants, safety solenoid cover which renders the valve electrically inoperative when cover is removed, and integral junction box large enough to accommodate 6 in. taped pigtail leads. Junction box has threaded conduit connection and retaining chain on junction box cover keeps cover with valve. Both solenoid cover and junction box cover are fitted with captive fasteners to prevent loss.

The valves are available in single and double solenoid types, for foot, sub-base or manifold mounting, in ¼, ⅜, ½ and 1 in. pipe sizes. Pilot solenoid coils for operation on either ac or dc, any voltage can be supplied. Pressure ranges are: 35 to 200 psi air and 35 to 125 psi hydraulic oil for both single and double solenoid valves with internal pilot supply; 0 to 250 air, hydraulic oil and water for both single and double solenoid valves with external pilot supply; 50 to 125 for water for single and double solenoid valves with internal pilot supply; within 1 in. Hg absolute vacuum for single and double solenoid valves with external pilot supply. Valvair Corp., 454 Morgan Ave., Akron 11, Ohio.

For more information—
Circle 58, inside back cover

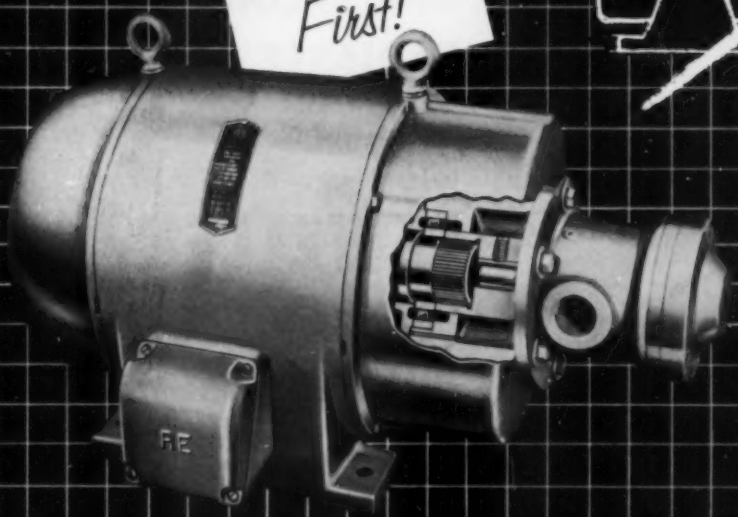
Small-Size Hydraulic Power Unit

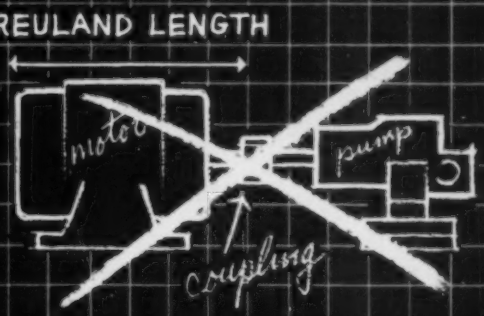
This hydraulic power unit measures 9 x 6 x 4½ in. width. It requires no mounting base and may be mounted in horizontal or vertical position. In vertical mounting position, the pump may be inclined as much as 45 deg in any direction from vertical, even while operating.

The unit consists of an electric motor, a high-pressure, low-volume pump, couplings, integral reservoir,

(Continued on page 274)

Another **REULAND** *First!*





- NO PLATFORM TO BUILD
- MUCH SHORTER LENGTH
- AUTOMATIC, PERFECT ALIGNMENT
- 30 H.P. 2½" SHORTER THAN FORMER 15 H.P. MODEL

NEW, **REULAND** *HYDRAULIC PUMP MOTOR features FAST, SPLINE-COUPLED hook-up!*

Perfect alignment ...in 1/10th ordinary time

You can hook up a Reuland motor and any standard make hydraulic pump in a matter of only seconds. All you have to do is slip the spline coupling onto the motor's spline shaft and attach the pump flange to the endbell.

Absolutely perfect alignment is assured. There is no tinkering around with a mounting platform and your finished job always has a sleek, well-designed appearance. Takes only a tiny fraction of the ordinary time.

For all standard pumps

Regardless of the pump you are now using, you can adopt this exclusive new Reuland hook-up. If your pump is not a standard make we can quickly adapt to your setup. The Reuland method is so radically simple you will be amazed at the tremendous advantages.

Coupling supplied with motor

Buy a Reuland hydraulic pump motor and you need nothing more. Spline coupling and drilled-and-tapped endbell are supplied ready for immediate pump attachment. (Adaptable to either single or double end pump installations.)

Use these new Reuland motors and you will save platform mounting expense and alignment time. You achieve compactness and better looks *plus* longer pump life through factory engineered alignment. For FREE ENGINEERING LITERATURE please write for folder No. 1109.

Don't pay for special-motor development before you check Reuland's

Special-Motor Library

Hundreds of different and unique electric motors — one of which may already be made to order for your needs. Originally designed for special uses. Now available to help you save expensive development work and put you in production faster!

Write for free booklet on HOW TO USE the Reuland Library!

Other Reuland firsts...

First FLUID-SHAFT MOTOR (First with internal fluid coupling)
First ALL-ALUMINUM MOTOR FRAMES
First THROUGH-SHAFT MAGNETIC BRAKES
First FOOT-MOUNTED DISC TYPE MAGNETIC BRAKES
First SLIP RING MOTORS IN SMALL #66 FRAMES

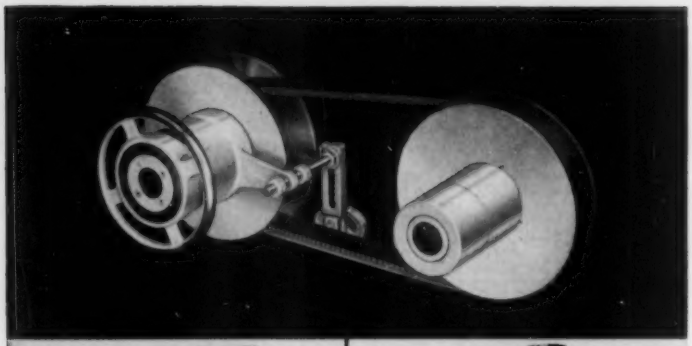
Free General Catalog of the COMPLETE Reuland Line of Standard and Special Motors sent on request

REULAND MOTORS

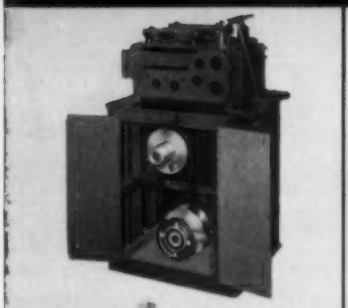
REULAND ELECTRIC COMPANY

Western Division: Alhambra 46, California • **Eastern Division:** Howell 46, Michigan

Distributors in all principal cities

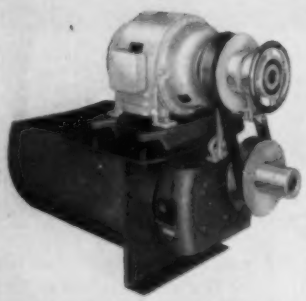


DIRECTLY APPLY/CONNECT VARIABLE SPEEDS with LEWELLEN COMBINATION PULLEYS

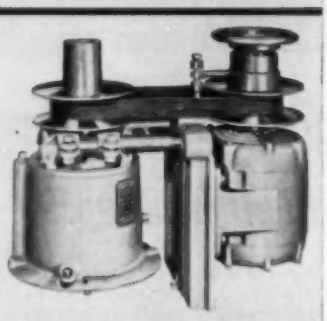


Perfecto Straightener and Feeder incorporates size 308 Combination Pulleys to provide 7 to 63 r.p.m. stock speeds.

Romulus three-dimensional tracer type Milling Head incorporates size 310 Combination Pulleys, providing 200 to 1800 r.p.m. spindle speeds.

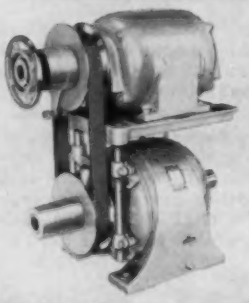


With Modor screw conveyor driver



With Foote Vari-Mount Reducer—vertical or horizontal flange installation

With Falk shaft-mounted reducer—including Dial indicator



With Foote Vari-Mount Reducer—horizontal foot-mounted installation

Where there are two parallel shafts—usually a motor and machine shaft—apply variable speeds by directly connecting the two with LEWELLEN COMBINATION PULLEYS.

Combination Pulleys are versatile power components—perform smoothly and dependably—operate in any position—require no supporting brackets—include convenient controls and accessories.

Handwheel of one Pulley regulates pitch ratios of both Pulleys at fixed shaft centers. Range of speeds is the multiple ratios of both Pulleys.

LEWELLEN COMBINATION PULLEYS—

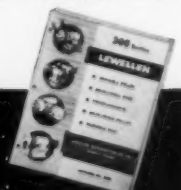
ratings to 15 H.P.
speed ranges to 10:1
selection of center distances
selection of operating speeds

offer widest latitude for directly applying variable speeds.

FOR SLOW OPERATING SPEEDS

Lewellen Combination Pulleys connect motor—and variable speeds—to reducer. Easily assembled, standard components comprise a motorized variable speed unit. The power package is compact, accessible, and economical.

Foote Bros. Vari-Mount Reducers are now catalogued for selection of ratings, service factors, speed ranges, and output speeds.



WRITE FOR CATALOG No. 60-A

COMPLETE NEW SECTION ON COMBINATION PULLEYS

LEWELLEN MANUFACTURING CO., COLUMBUS, IND.

DISTRIBUTORS IN ALL INDUSTRIAL AREAS • IN CANADA — PEERLESS ENGINEERING SALES LTD., TORONTO — MONTREAL

DESIGNED FOR:

LONG LIFE
MAXIMUM STRENGTH
POSITIVE SEAL
LOW COST

Lamson FORGED STEEL PIPE PLUGS

Lamson Pipe Plugs are available in the following sizes: ⅛", ¼", ⅜", ½" and ¾".

Have you checked the Pipe Plugs you are using lately? Like so many common but important parts to your product, Pipe Plugs are apt to be taken for granted with a resultant loss in production time and efficiency.

Lamson Pipe Plugs are FORGED for maximum strength and positive sealing. Heads will not chip or break under severe wrenching. This means savings for you on the production line. The ROLLED "DRYSEAL" THREADS of Lamson Pipe Plugs guarantee maximum toughness and correct tolerances are assured by Lamson's famous "Quality Control" system.

Yet, despite the extra protection and value Lamson Pipe Plugs offer, they cost no more than other types. You get true premium quality at a low "regular" price.

So next time specify Lamson Pipe Plugs—in steel, brass, bronze or aluminum—and give your product the extra advantage it deserves.

Lamson & Sessions

The LAMSON & SESSIONS Co.
1971 West 85th St. • Cleveland 2, Ohio
Plants at Cleveland and Kent, Ohio • Birmingham • Chicago

FOR PROMPT DELIVERY AND HELPFUL SERVICE, ORDER FROM YOUR LAMSON DISTRIBUTOR

PLUG NUTS Ideal for blind or hard-to-reach places.

PIPE PLUGS Forged steel, heat-treated.

"1035" SET SCREWS Cup point type, hardened and heat-treated.

PLACE BOLTS With "Built-in" spring action for positive locking.

LOCK NUTS Economical, vibration proof. Can be used repeatedly.

"BENT BOLTS" Including U bolts, eye bolts, hook bolts, etc.

MACHINE SCREWS Clutch and Phillips recessed head screws.

SEMS Pre-assembled lockwashers on tapping and machine screws.

Easy-Flo's the ticket on this...

BELTLINE TO FAST, LOW-COST BRAZING

Moving right along 400 to 450 an hour, brass compressor valve bodies and tube adapter caps are brazed as they ride through the propane-oxygen heating section. All the girl does is assemble the parts with the ring of EASY-FLO 45 in place, (see left) brush on flux and set assemblies on the belt.

Similar setups can be readily devised for handling a wide variety of parts. We'll be glad to send a field engineer to help you work one up for your parts. No obligation.

READ ALL ABOUT IT IN BULLETIN 20...
It explains how and why the combination of properties you get in the EASY-FLO low-temperature silver brazing alloys, makes such fast, low-cost brazing setups practicable. Write for a copy today.

ORIGINATORS OF EASY-FLO & SIL-FOS

HANDY & HARMAN

General Offices: 82 Fulton St., New York 38, N. Y.
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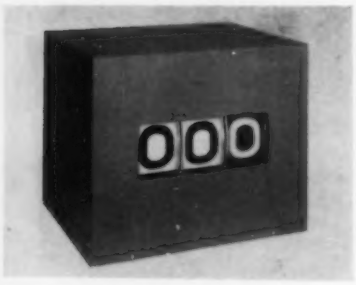
automatic valving for cylinder actuation, optional pressure switch and mounting bracket. Pressure up to 3000 lb are developed, with 5000 lb peaks. Two internal valvings are available: one locks cylinder in infinite holding position, the other allows free movement of cylinder except during actuation. Available with 115 v universal electric motors. Oil-Dyne, Inc., 2115Z W. Marquette Road, Chicago 36, Ill.

For more information—
Circle 59, inside back cover



Down-Time Recorder

The device records to the second when any machine is down, no matter what reason. Numerals are 6 in. high, and visible from 200 ft. Plugs in anywhere, and automatically resets itself. Down-Time Recorders, Inc., 1323 S. Wabash Ave., Chicago, Ill.

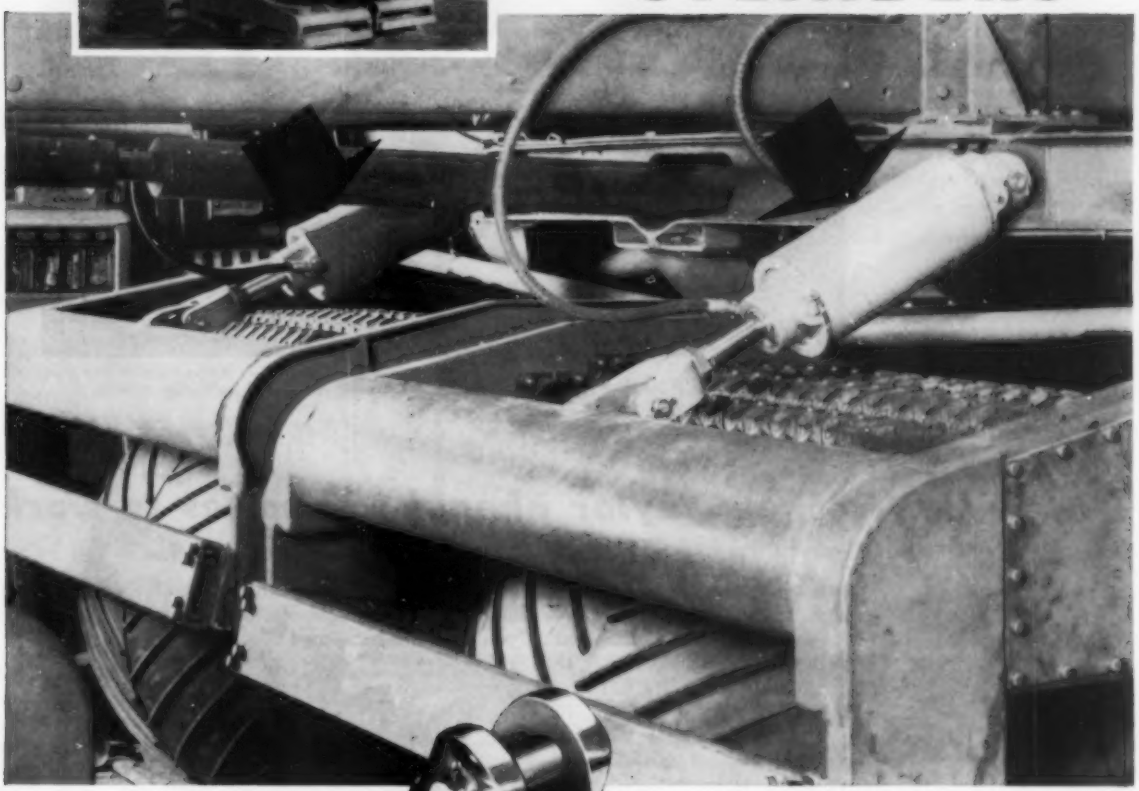
For more information—
Circle 60, inside back cover

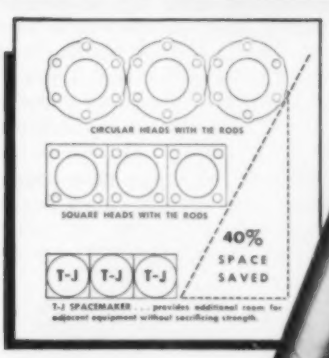
Variable Speed Drives

Variable pitch motor pulleys in $3\frac{3}{8}$, 4, 5 and $5\frac{3}{4}$ in. dia with ratings from $\frac{1}{3}$ through 1 hp for use with A and B section belts, are now available in various combinations of fixed-center drives providing speed variations up to $7\frac{1}{2}$:1 ratio. The drive pulley consists of two conic halves, one mechanically operated and one spring-loaded. Proper belt tension is maintained, maintaining fixed shaft centers,

(Continued on page 278)

Arctic Cargo Carrier Depends On T-J Spacemaker CYLINDERS





ALL MODELS . . . OFF SHELF DELIVERY

MEETS WITH ALL JIC RECOMMENDATIONS

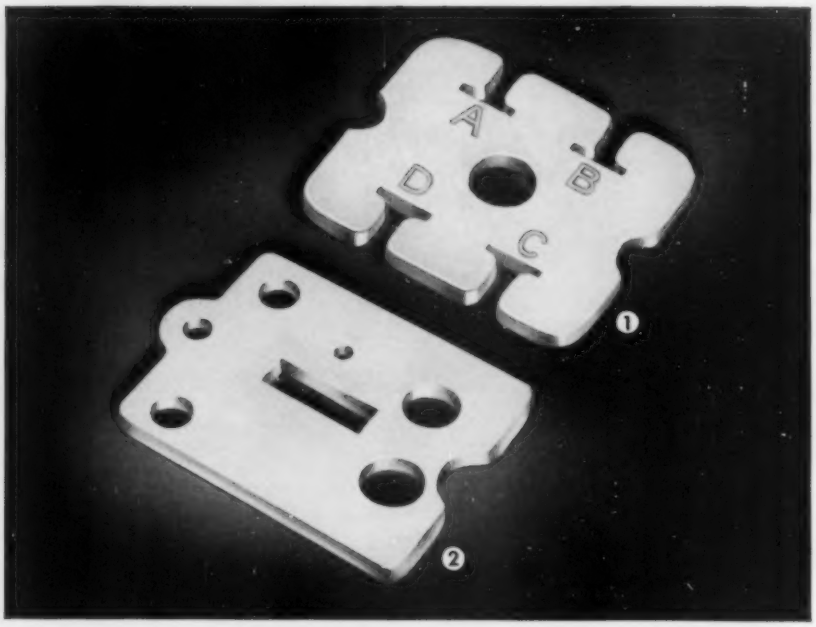
Saves 40% Space!

No Tie Rods For Greater Strength

Differential axle loading through T-J Spacemaker Air Cylinders forms a controlled walking beam in this Teracruiser, designed and produced for the Army Ordnance Corps by the Four Wheel Drive Co., Clintonville, Wis.

Weight of cylinders was important factor in choosing T-J Spacemakers, which reduce weight while providing same displacement and extra high safety factor. Fast delivery and space-saving features also favored T-J. Exclusive with T-J are new Super Cushion Flexible Seals for Air (to 200 P.S.I.) . . . and New Self-Aligning Master Cushion for Oil (to 750 P.S.I.). Hard chrome plated bodies and piston rods are standard, at no extra cost. Wide range of styles, capacities . . . 64,000 combinations *off the shelf!* Write for bulletin SM-155-3. The Tomkins-Johnson Co., Jackson, Mich.

T-J TOMKINS-JOHNSON
RIVETORS AIR AND HYDRAULIC CYLINDERS CUTTERS CLINCHORS



1. Grade XP-240 for warm punching. *2. Grade XXP-241 for hot punching.*

Put these two new Taylor phenol laminates to work

HERE are two major additions to the extensive Taylor line of laminated plastics. There's a good chance that a product you're now designing can be improved through the use of these new materials . . . or that products now in your production line can be more economically made with them. Check the features of these outstanding paper base, phenolic laminates. They may be exactly what you're looking for.

Grade XP-240 is a warm punching grade that requires some heat when punching more complicated shapes, though much less heat than comparable NEMA grades . . . and can be cold punched in thicknesses to 1/16". With this material, there's no lifting around punched holes, and check-in is negligible. It has excellent staking characteristics, and good dielectric strength. XP-240 has much to recommend it for such applications as insulating washers, terminal boards, plug and socket bases, switch bases, panels for sub-assemblies, and terminal strips.

Grade XXP-241 is a hot punching grade with excellent physical and electrical characteristics, plus good moisture-resisting properties. It's dimensionally stable, punches without lifting around holes, and machines with clean-cut edges. XXP-241 can be used to advantage in such applications as condenser stator brackets, wave switch rotors and stators, plug and socket bases, terminal boards and sub panels, insulating washers. Both laminates are available in sheets approximately 49" x 49".

If you're interested in fitting these tough, versatile materials into your plans, Taylor engineers will help you work out design and production details. Call or write for the facts.

TAYLOR FIBRE CO. • Plants in Norristown, Pa. and La Verne, Calif.

Taylor Fabricating Facilities

Your production can be simplified . . . schedules safeguarded . . . inventory headaches cured . . . and over-all costs reduced by having Taylor fabricate finished parts to your specifications. Efficient, modern facilities are ready to serve you. Get in touch with Taylor about your specific requirements.

TAYLOR
Laminated Plastics
Vulcanized Fibre

NEW

VICKERS

Miniaturized

PISTON TYPE HYDRAULIC PUMPS

3000 psi . . . CONSTANT DISPLACEMENT

These new miniaturized hydraulic pumps were developed by Vickers for limited life applications such as missile and ram air turbine driven hydraulic systems . . . also for motorpump assemblies supplying emergency power on aircraft.

A distinctive feature is adaptability to manifolding and special mounting. This permits integration with the balance of a "packaged" hydraulic system to provide hydraulic power in the most compact and lightweight form yet devised. Some sizes are capable of delivering more than five horsepower per pound of weight.

Available in four size series, this miniaturized pump has the same basic characteristics as the standard Vickers piston type pump which has been establishing outstanding performance records on aircraft since 1940. Ask nearest Vickers Aircraft Application Engineer for further information.

VICKERS INCORPORATED

DIVISION OF SPERRY RAND CORPORATION

ADMINISTRATIVE and ENGINEERING CENTER

DEPARTMENT 1454 • DETROIT, 32, MICH.

Application Engineering and Service Offices: **El Segundo, California, 2160 E. Imperial Highway • Detroit 32, Michigan, 1400 Oakman Blvd. (Service Only) • Arlington, Texas, P. O. Box 213 • Washington 5, D.C., 624-7, Wyatt Bldg. •** ***Additional Service facilities at:*** **Miami Springs, Florida, 641 De Soto Drive**

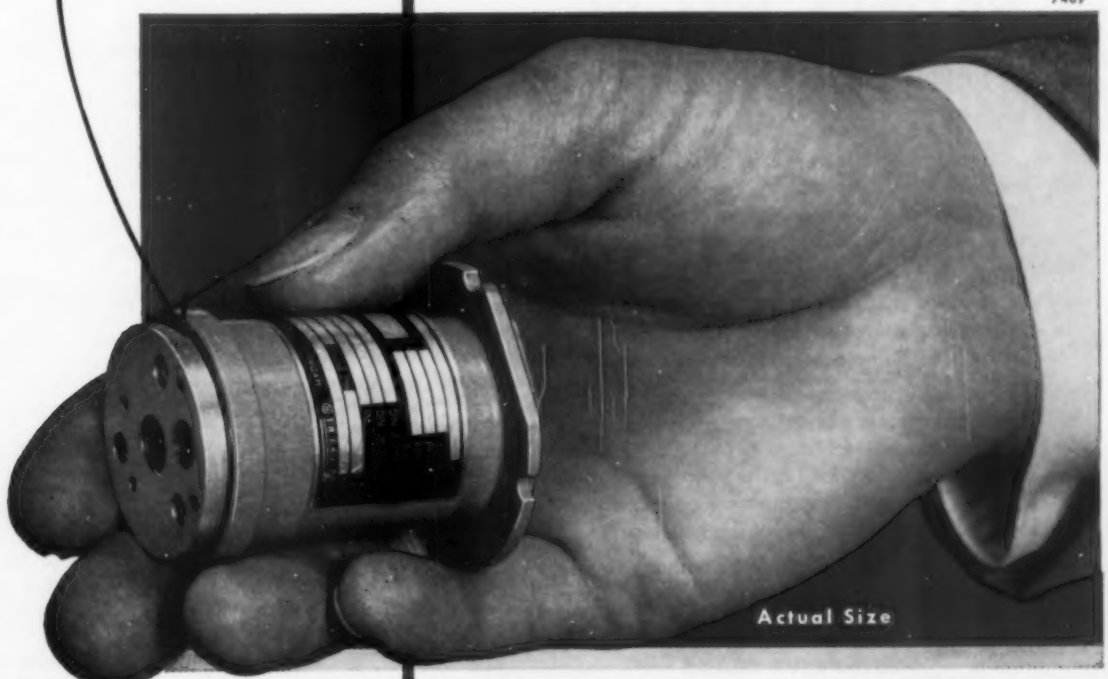
TELEGRAMS: Vickers WUX Detroit • TELETYPE "ROY" 1149
CABLE: Videt

OVERSEAS REPRESENTATIVE: The Sperry Gyroscope Co., Ltd.— Great West Road, Brentford, Middx., England

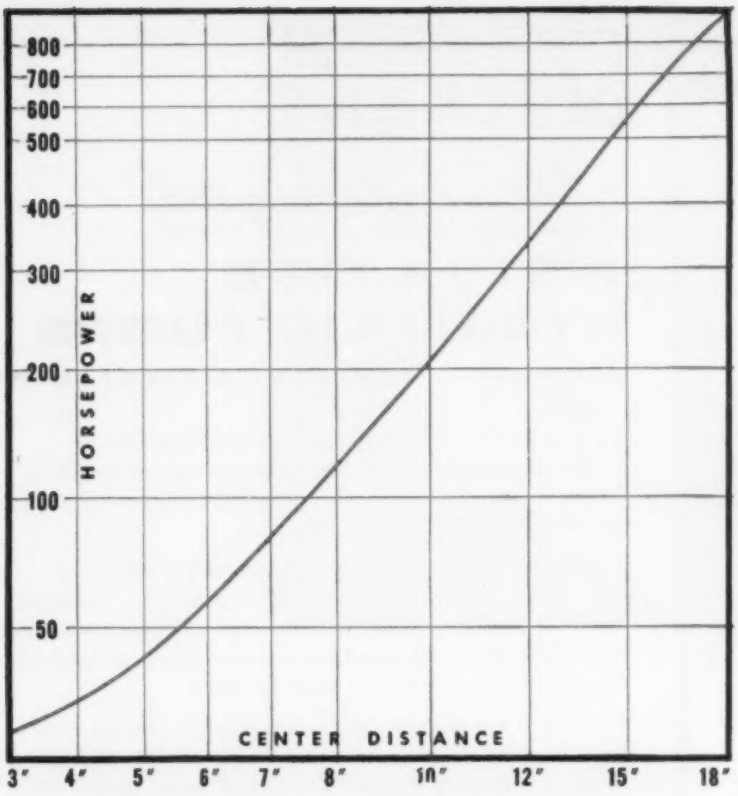
Engineers and Builders of Oil Hydraulic Equipment Since 1921

This Hydraulic Pump has 4.3 hp output @ 3000 psi and 12,000 rpm. Weight 0.9 lb.

7469



A large expansion program now in its early stages means large opportunities for additional engineers at Vickers. Write for information.



WE LEFT COMPETITIVE RATINGS OUT OF THE CHART PURPOSELY..

... because we think the load-carrying capacity of Cone-Drive speed reducers is pretty impressive all by itself. Then, we've also got a lot of friends in the worm gear speed reducer business. And they make pretty fair reducers themselves.

Two things are responsible for the high capacity of Cone-Drive speed reducers. First, we use extra-heavy gears mounted on oversize taper roller bearings in reinforced, heavy housings. Extra "beef' alone accounts for part of our capacity.

Even more important, however, is the Cone-Drive double-enveloping worm gear design. Here, we literally wrap worm and gear around each other to put ⅛ of all teeth in continuous full-depth contact. This results in spreading tooth contact ovet a greater area, reducing pressure on individual teeth, increasing load capacity and life of the gearing.

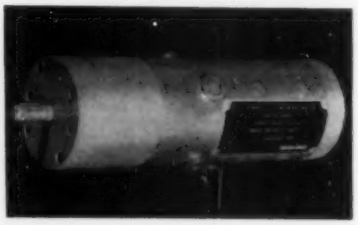
Ask for Bulletin 600C without obligation.

CONE-DRIVE GEARS
Division Michigan Tool Company
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
7171 E. McNichols Road • Detroit 12, Michigan

and requiring no adjustable motor base. Driving speeds may be changed without stopping the motor.

Different diameter pulleys may be used in combination to provide a wide range of output speeds and speed ratios. Stock bores available are: ¼, ⅝, ¾ and ⅞ in. Gerbing Mfg. Corp., 11800 Milwaukee Ave., Northbrook, Ill.

For more information—
Circle 61, inside back cover



Actuator Motor

Designed for controlling brake-flaps in missiles and weighing 2½ lb, this motor operates an electro-magnetic brake, which will stop the output shaft within 60 deg of rotation after circuit is broken and lock the shaft in that position. The motor delivers 0.208 hp at 28 v/dc, with 18 amp maximum current at full load. It will operate from −65 F to 450 F. It can be built to handle peak loads up to 0.4 hp.

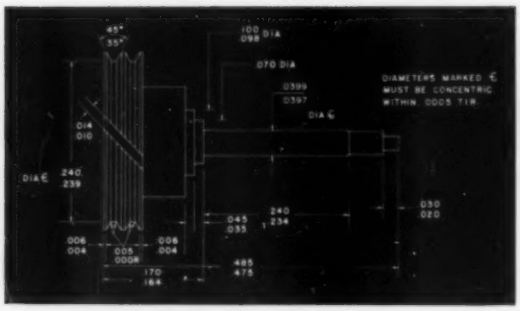
The motor is reversible and has a two-stage planetary gear reduction that delivers 250 rpm at the output shaft at armature speed of 15,000 rpm. It is a four-pole, series wound motor, 2.1 x 6.6 in. length. Motronics Corp., 241 Concord, Glendale, Calif.

For more information—
Circle 62, inside back cover

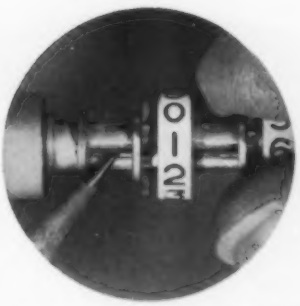
Tachometer for Rotating Machinery

This speed indicator is used on integral horsepower motors and automatic machinery. The tachometer delivers an a-c voltage whose frequency and magnitude are said to be linear with speed, making the design particularly useful to controls sensitive to either frequency or voltage. The generator sinusoidal voltage may be as high as 25 v per 100 rpm and the

(Continued on page 282)



Inspection of incoming precision shafts took 10 to 15 minutes each by mechanical gaging—involved concentricity, diameters, shoulder locations, and other tough-to-measure dimensions to tolerances of .0002". Doing the work on a Kodak Contour Projector cut time to 2 to 3 minutes per shaft.



The problem was to check many small calculating machine parts averaging about 13 critical dimensions for each with shapes mostly complex. With carefully engineered mechanical gages, inspection time averaged 50 seconds each. Optical gaging on a Kodak Contour Projector brought the average down to 12 seconds.

Spacing the parallelism of a special tuning condenser for electronic test equipment had to be held to very close tolerances. "Use of the Kodak Contour Projector," the company reports, "permits economical measurements of parallelism to an accuracy impossible to obtain by other methods."

On a flexible rubber-like part, rejects ran as high as 30%. By using a Kodak Contour Projector to measure the parts and then plotting results by statistical quality control methods, production changes were made that resulted in rejects dropping from 30% to less than ¼ of 1%. Optical gaging eliminated distortion of the part while gaging, and proved 4 to 5 times faster than usual methods.

One instrument inspects these varied parts

Here is another economy optical gaging can provide: switching from one part to a second part requires only a change of chart and fixture. You still use the same basic instrument. And with a Kodak Contour Projector, the variety of parts you can check is almost without limit. Here's why:

1. *Capacity*—Screen size on an optical comparator does not restrict the size of parts you can handle, for multiple-position fixtures allow the handling of parts larger than the screen itself. What's important is the staging area—and Kodak's unique relay lens provides uniform ample clearance regardless of magnification. The distortion-free image lets you measure anywhere on the viewing screen. The choice of lenses, of horizontal or vertical projection, and of surface or shadow illumination gives you the greatest possible flexibility.
2. *Ease of operation*—Kodak Contour Projectors are designed for maximum speed and minimum operator training. The bright screen image reduces fatigue, lets you use the instrument in normal room light. Images are erect and unreversed at all magnifications. Finger-tip controls are within convenient reach of the operator.
3. *Optical stability*—The adjustment-free optical elements on Kodak Contour Projectors eliminate the need for operator adjustments. Rigidly mounted lenses and mirrors maintain alignment and position. Rugged construction withstands rough and heavy use.

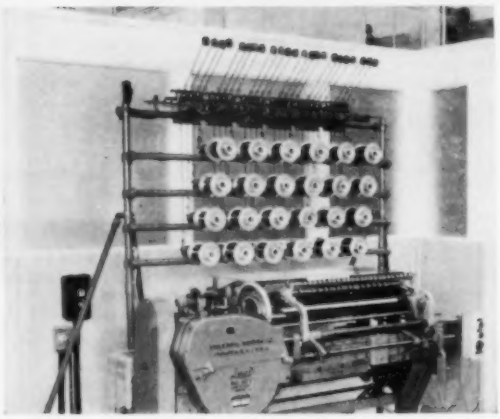
Whether you are now using optical gaging or just considering it, you should have a copy of the booklet, "Optical Gaging with Kodak Contour Projectors." It gives complete details on Kodak optical gaging equipment and how it can work for you. Write to *Special Products Sales Division.*

EASTMAN KODAK COMPANY, Rochester 4, N. Y.

the KODAK CONTOUR PROJECTOR

Kodak

if it's worth engineers' time . . .



Belden

MAGNET WIRE

- Beldol
- Celenamel
- Nylclad
- Beldenamel
- Formvar
- Alkanvar
- Formbond

Squares & Rectangulars

. . . it's worth engineered wire

An ever-increasing number of insulations for an ever-increasing number of electrical and electronic products puts growing emphasis on specialized wires engineered for the job. Your engineered product merits Belden wire engineering service.

Belden

WIREMAKER FOR INDUSTRY
SINCE 1902
CHICAGO

4-M

Magnet Wire • Lead and Fixture Wire • Power Supply Cords, Cord Sets and Portable Cord • Aircraft Wires
Welding Cable • Electrical Household Cords • Electronic Wires • Automotive Wire and Cable

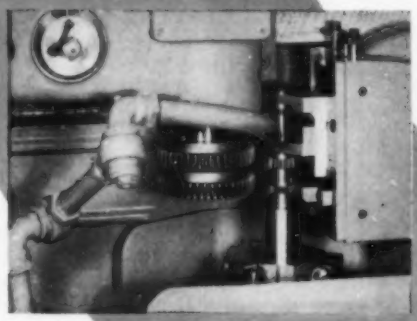
How Gear Shaper *Versatility* helps IMPROVE DESIGN

Quick-acting, air-operated diaphragm chuck speeds loading and unloading of pump rotor on Fellows No. 7A-Type Gear Shaper.

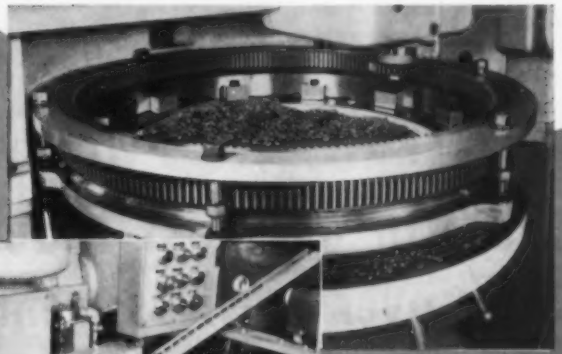
The Gear Shaper principle of generating with a reciprocating tool provides a versatile and economical method of manufacture which allows the engineer much greater latitude in the design of parts for low cost production. Special fixtures and controls permit cutting gears, intricate contours and other shapes in tandem or combination where otherwise, special-purpose machines might be required.

Free booklet — "The Art of Generating with a Reciprocating Tool" — shows in engineering detail how you can use Fellows Gear Shaper versatility to simplify and improve design. Write for it now.

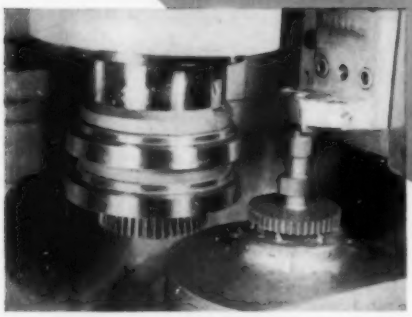
THE FELLOWS GEAR SHAPER COMPANY
78 River Street, Springfield, Vermont
Branch Offices: 319 Fisher Building, Detroit 2
5835 W. North Ave., Chicago 39
150 W. Pleasant Ave., Maywood, N. J.
6214 W. Manchester Ave., Los Angeles 45



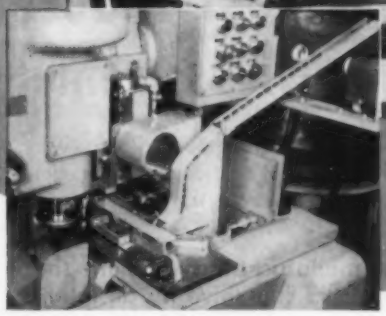
Two Gear Shaper Cutters in tandem cut automotive gears simultaneously. Center support fixture holds part in No. 4GS Gear Shaper.



Special fixture holds combination internal-external gear while internal gear is cut on 36-Type Gear Shaper.



Two cams and one gear are cut simultaneously on a gasoline motor part. Center support fixture holds part in No. 4GS Gear Shaper.



Fixture for automatically loading and unloading automotive pinions on the No. 4GS Gear Shaper.

THE PRECISION LINE **Fellows** *Gear Production Equipment*

WEST VIRGINIA SPECIAL SECTIONS

did the job for

TRADE YALE MARK

The channels of Yale industrial lift trucks are rolled to specification by West Virginia Steel.

Steel in use cost reduced 30% over previous methods

West Virginia Steel & Manufacturing Co. was able to produce a hot rolled section to the exacting Yale specifications. This cut the cost of specially rolled channels 30%.

You may have a manufacturing problem that West Virginia engineers can solve by designing special sections to your own specifications and tolerances.

Write or Call for FREE ENGINEERING CONSULTANT *Service!*

west virginia steel and MANUFACTURING COMPANY

P. O. Box 316 Huntington, West Virginia

frequency is 30 cps per 100 rpm. No slip-rings, brushes, or contacts are employed. Wac Engineering Co., 35 S. St. Clair St., Dayton 2, Ohio.

For more information—
Circle 63, inside back cover

Nylon Pipe

This pipe can be supplied in straight lengths or continuous coils, in sizes from ⅜ to 1¼ in. OD, with wall thickness from 0.025 to 0.125 in. Manufacturer states that this nylon pipe is capable of conveying liquids at temperatures and pressures higher than permissable for other piping materials. Danielson Mfg. Co., Danielson, Conn.

For more information—
Circle 64, inside back cover

Toggle Valve

This valve employs an overcenter, snap action control. It may be used in air, gas, oil and water service. It is a three-way, two-position valve, in

(Continued on page 285)

DOW CORNING CORPORATION

Silicone News

FOR DESIGN ENGINEERS No. 29

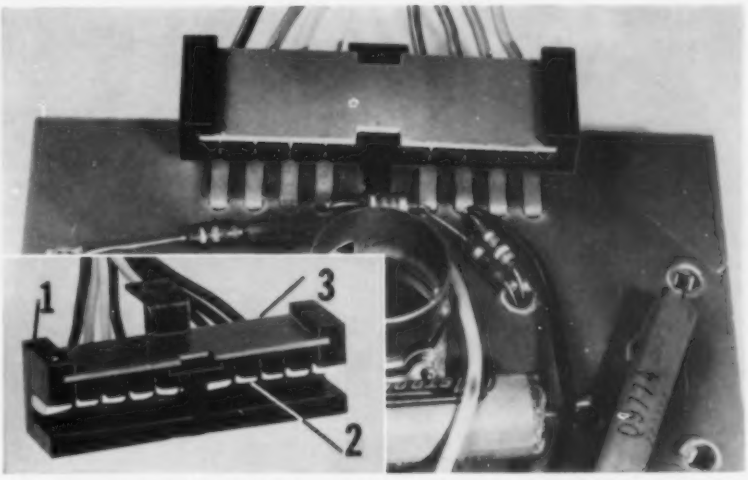
New Silicone Bonded Mica Tape More Flexible, Easier to Handle

Mica Coated Products Co., Salem, Mass., has developed an improved Class H insulating material comprised of a thin coating of ground mica bonded to glass cloth with Dow Corning 994 Varnish.

According to the manufacturer, this new combination provides greater dielectric strength and heat resistance than possible with silicone-glass alone. In addition, it has far greater flexibility than conventional tapes made with mica-splittings. A 5-mil thickness of it may be wrapped around a 1/32" mandrel without harm.

This new material is unusually uniform in gage, finish and dielectric strength. Since it is neither tacky nor slippery, there is no danger of its welding together or blocking when guillotine-cut.

The flexibility of Dow Corning 994 Varnish and its compatibility with mica led to its use as the binder for ground mica coating on two other new tapes by Mica Coated Products Co.: an alkyd resin dipped glass cloth for temperatures up to 170 C; and Mylar, for Class B applications. The silicone-mica combination gives both tapes appreciably greater resistance to fire and arcing. *No. 290*



(1) Phenolic wire holder (2) Silastic strip (3) Micarta cover.

WESTINGHOUSE USES SILASTIC IN NEW LOW COST CONNECTIONS

Right along with the new and frequently more complex designs that give products greater consumer appeal, there is also a continuing need for other new designs that help reduce assembly costs and keep the product in a competitive position costwise. Just such a design idea has taken form in the push-on connectors which join circuit sub-assemblies on the Westinghouse Automatic Corox range.

The ultimate in design simplicity, these push-on connectors force the lead wires to make their own connections without clips, clamps, screws or solder. The connectors consist of only three parts: (1) a molded phenolic wire holder; (2) a compression strip of Silastic,* Dow Corning's silicone rubber; (3) a plain Micarta cover which slips over the exposed wires to permit safe handling.

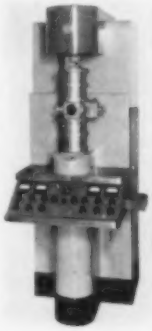
The stripped wires are inserted into their proper numbered V-notches in the holder and are simply bent over the compression strip of Silastic. The Silastic provides a resilient rubber "spring" which presses the wires into tight contact with the terminals on the amplifier mounting board. Silastic is specified by Westinghouse designers because of its superior dielectric strength and permanent resistance to compression

*T. M. REG. U. S. PAT. OFF.

(cont'd pg.2)

Assure Efficiency of Electronic Microscope With Silicone Pump Fluids

Stymied by the limitations of organic diffusion pump oils, many designers now improve product performance by specifying Dow Corning silicone fluids for vacuum pumps. Take the RCA electron microscopes and diffraction cameras, for example.



A vacuum in the range of 10^{-4} mm. of mercury must be maintained in these instruments to permit an electron to leave the filament and travel the entire length of the chamber without hitting an air molecule.

Each time an instrument is opened, however, the chamber must be completely evacuated or "pumped-down" before it can be used again. Pumping down used to be the most time-consuming part of operating these instruments, but now, through improved design, RCA has reduced pump-down time to less than two minutes.

During normal operation of RCA's Model EMT, large amounts of raw air frequently enter the diffusion pump while it is hot. Exposed to such conditions, organic diffusion pump oils rapidly carbonize and break down. To assure excellent service right from the start, RCA furnishes a bottle of Dow Corning 702 Fluid with each new microscope or camera.

A recent check indicates that even after two years of continuous use in these instruments, the Dow Corning silicone fluid remains in excellent condition.

(cont'd pg.2)

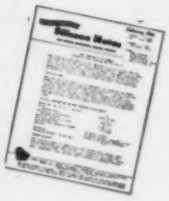
FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE

DOW CORNING CORPORATION

Silicone News

DOW CORNING PUBLICATIONS ON NEW DEVELOPMENTS AND TECHNICAL DATA . . . .



Silicone-based protective coatings are durable protective finishes for appliances; long-lasting maintenance paints for equipment exposed to adverse conditions. A recently published brochure includes typical applications and a list of companies formulating silicone paints. *No. 295*

1956 Reference Guide to Dow Corning Silicone Products. A concise, comprehensive, 12-page reference that is convenient-to-use. It's packed with data, properties, and information on how you can use silicones in designing new equipment, improving performance and reliability of original equipment, or reducing production and maintenance costs. *No. 296*

"Effects of High Temperature on the Properties of Organic and Silicone Rubbers," a recent article from RUBBER AGE, reviews the marked immediate effects of heat aging on physical properties of rubbery materials. Includes 20 graphs which enable design engineers to select the most suitable type of rubber for applications where retention of properties is critical. *No. 297*

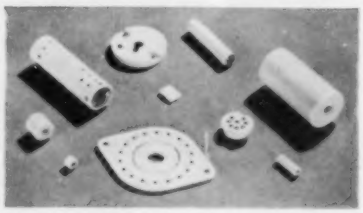
"151 Uses for Silicones in Metalworking." A reprint from STEEL, condenses and lists known applications for silicones in Design, Production, Maintenance and Miscellaneous categories. Provides a quick reference as to how Dow Corning Silicones help solve problems in many segments of the metalworking industry. *No. 298*

Silicone-Glass Laminates for electrical and mechanical applications are described in new brochure which illustrates parts used in typical industrial applications. Also provides engineering information on silicone-glass laminates and lists fabricators of such laminates. *No. 299*

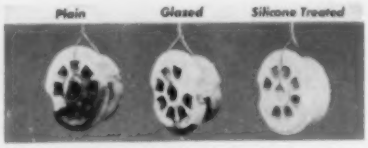
New engineering brochure featuring Silastic 50 and Silastic 80 is now available. A convenient reference, it includes detailed information on the physical and electrical properties of these two practical, general purpose silicone rubbers. *No. 300*

Silicone Coating Cuts Cost of Ceramic Electrical Insulators

Imaginative use of new materials frequently enables designers to create a competitive sales advantage while cutting production costs. Here's a case in point from Centralab Division of Globe-Union Co., Milwaukee.



Centralab reports that a silicone treatment is rapidly replacing conventional glaze coatings on ceramic electrical insulators. Production savings with the silicone treatment range as high as several dollars per thousand units, permitting Centralab to quote competitively for ceramic against ordinary plastic molding materials.



Greater moisture repellency of silicone treated ceramic tube socket is demonstrated by dunk test using colored water.

The new treatment consists simply of a dip in Dow Corning 200 Fluid followed by a short baking cycle, contrasted to the costly individual air-brushing and high temperature kiln-firing required for a glazed surface. The silicone treatment gives equivalent or better moisture resistance and surface resistivity for all but the highest frequency applications.

Centralab now offers the silicone treatment on its entire line of steatite-ceramic parts including insulators, capacitor bodies, rotary switches and trimmers. Silicones have become such a strong selling point that, as a Centralab spokesman puts it, "Our sales department reviews every order or quotation request calling for glaze and recommends the silicone treatment where ever possible." *No. 293*

DIFFUSION PUMP *(continued)*

Tests by other leading producers of high vacuum equipment indicate that Dow Corning 702 Diffusion Pump Fluid helps to attain higher vacua in less time than possible with organic fluids. *No. 292*

WESTINGHOUSE *(continued)*

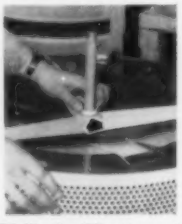
set. With the addition of screw-on brackets, these ingenious push-on connectors also serve to fasten the entire amplifier circuit to the range body, thus providing an additional saving in assembly time.

Today, designers are finding an ever increasing number of new uses for Silastic where product performance can be improved with a rubbery material that retains its physical and dielectric properties far beyond the limits of organic rubber. *No. 291*

SILASTIC PROTECTS BEARING ON MAYTAG CLOTHES DRYER

Over a broad temperature span, from —130 to 500 F, Silastic, Dow Corning's silicone rubber, keeps its shape and stays resilient. Here's how Maytag designers have translated this unique thermal stability into practical use in their automatic clothes dryers.

Backbone of the Maytag dryer is a sintered metal journal bearing which supports the drum shaft. This bearing is protected from moisture by a Silastic seal on the shaft. The seal, molded by Maytag, has been in use since the dryer was introduced three years ago.



Despite repeated exposure to steam and ambient temperatures ranging up to 170 F, the Silastic seal has demonstrated its ability to remain resilient and watertight for the full service life of the unit. *No. 294*

Dow Corning Corporation, Dept. 8607, Midland, Michigan

Please send me: 290 291 292 293 294 295 296 297 298 299 300

NAME _____

TITLE _____

COMPANY _____

STREET _____

CITY _____ ZONE ____ STATE _____

SILICONE NEWS is published for product design and development engineers by

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DOW CORNING SILICONES — *first in silicones*

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Standard Quality sets Quality Standards

The day-in, day-out excellence, the quality which is standard in every Curtis Universal Joint, has made the Curtis Joint the quality standard of the industry.

Each Curtis Universal Joint component is made from specially selected steel, individually heat-treated for a specific purpose. This accounts for the long life and dependable performance of Curtis Universal Joints.

CURTIS UNIVERSAL JOINTS

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- Fewer parts, simpler construction
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As near to you as your telephone

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which toggle remains in selected position. Operating pressures are from 0 to 100 psi. Orifice sizes up to $\frac{1}{8}$ in. dia are available. Valve parts are made from stainless steel, aluminum, and synthetic rubber. The valve is $1\frac{1}{2}$ x $1\frac{3}{4}$ x $\frac{5}{8}$ in. thick; weight is 3 oz. Barworth, Inc., 7 Industrial Pl., Summit, N. J.

For more information—
Circle 65, inside back cover

Heavy Duty Vacuum Switch

Operation of this switch is factory calibrated, and it opens and closes a contact at fixed vacuum values. Available for normally open or normally closed use at zero vacuum with settings up to 22 in. For use with 6, 12, or 24 v dc, but can be modified for low voltage ac. Supplied in either single terminal grounded or double terminal models.

Line connection made at center of back, $\frac{1}{4}$ x $2\frac{1}{8}$ in., top of terminal to end of pipe thread. Rochester Mfg. Co., Rochester 10, N. Y.

For more information—
Circle 66, inside back cover

Explosive Valve

This normally closed valve is a dead-tight, shut-off valve for long or short storage of gas or liquid under high pressure. It operates instantaneously by firing a small completely contained explosive squib. The standard model's flow passages are closed off by a solid, integral diaphragm inside the valve body. The unit is available with five different sets of inlet and outlet port arrangements.

Upon firing, an unobstructed flow

(Continued on page 288)

When product designs for welded steel

Have twice the rigidity... three times the strength

Yet require less material ...cost less to fabricate

WHY

aren't all your products designed for welding?

THE WELDED WAY

20% more rigid ...costs 44% less

Welded from 16 gauge sheet this power headstock weighs 28% less than cast iron design. Photo courtesy Oster Manufacturing Company, Cleveland, Ohio.

Let Lincoln show you how to duplicate these advantages in your products.

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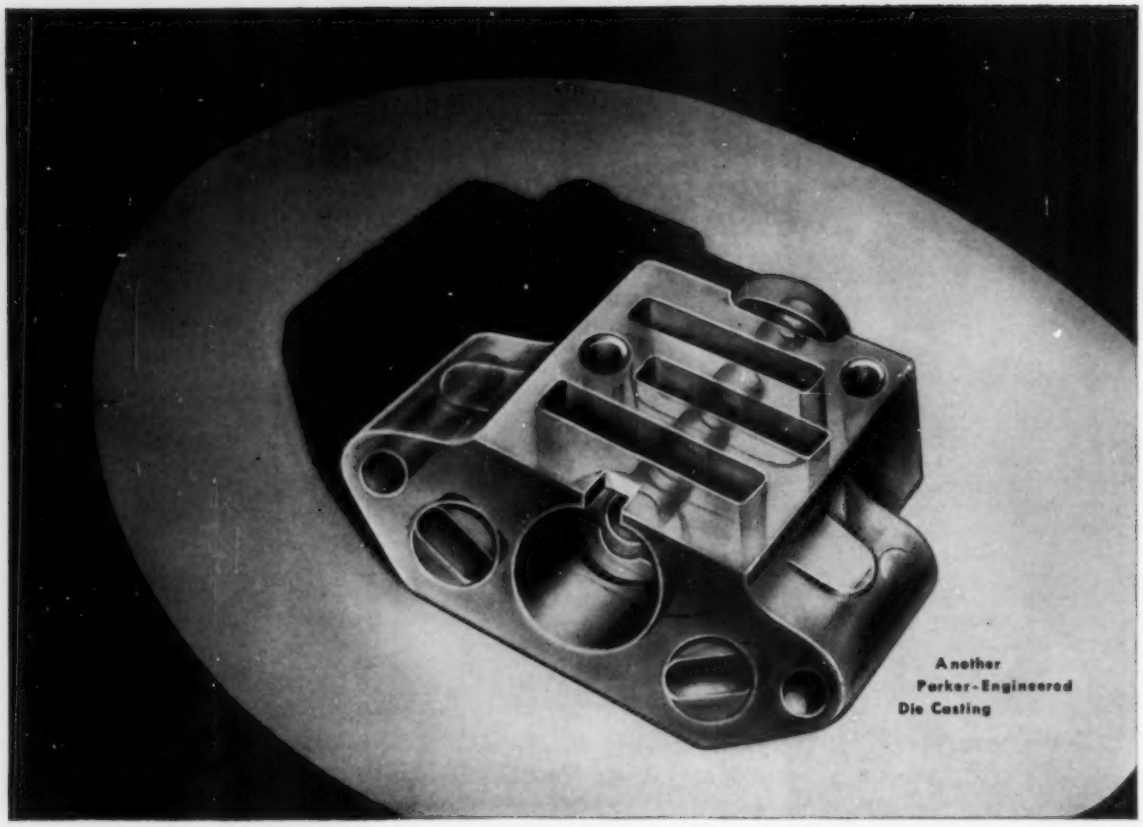
THE LINCOLN ELECTRIC COMPANY

Dept. 1315 • Cleveland 17, Ohio

Creating Lower Cost for Industry... With Welded Steel



HOLES AND ALL . . . In One Casting Operation

PARKER SALES ENGINEERS

CHICAGO 49, Ill.
Ollie J. Berger Company • 2059 East 72 Street

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William H. Broxterman • 2174 Buck Street

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GIRARD, Penna.
Daniel F Marsh • 35 Chestnut Street

KIRKWOOD 22, Mo.
Edward F Higgins, Jr. • 102 West Adams Street

WILTON, Conn.
Girard L. Palmer • Belden Hill Road

SYRACUSE, N. Y.
J. C. Palmer • 712 State Tower Bldg.

BELLEFONTE, Penna.
Warren G. Olson • 420 East Linn Street

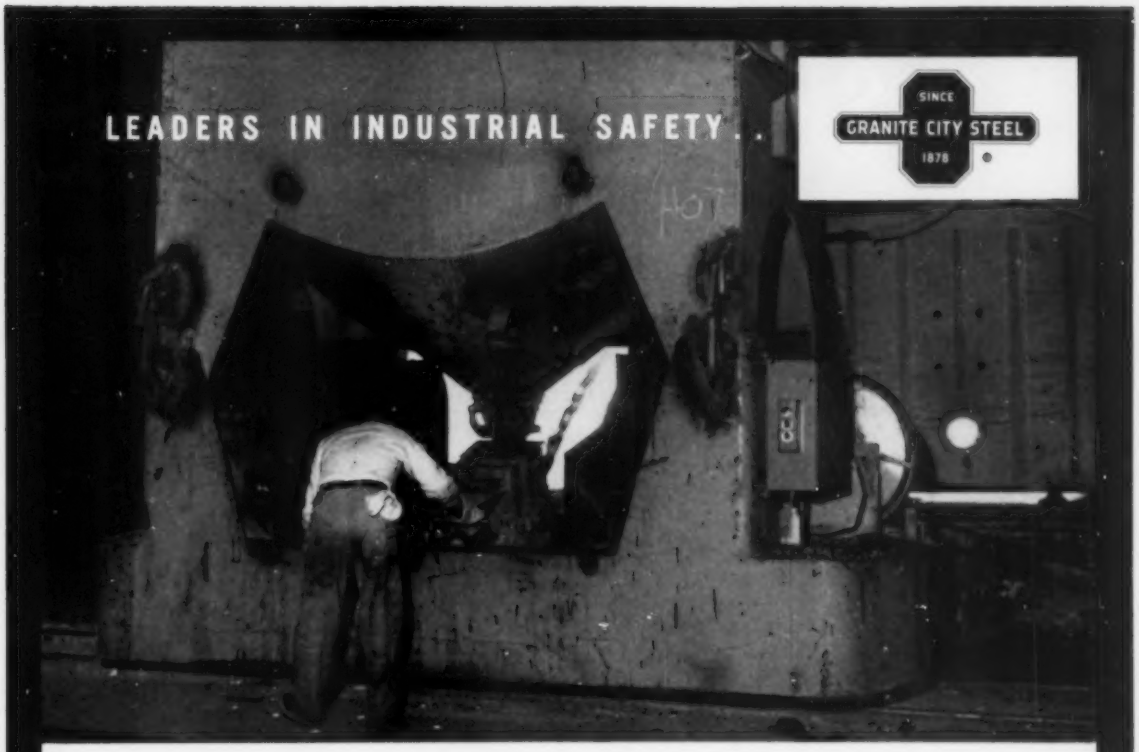
Just imagine the savings effected by producing this intricate part *complete* . . . in *one casting operation*. Here, certainly, is dramatic proof of the skill, experience and creative imagination of Parker die designers. And when you add to these Parker-engineered cost savings other advantages such as high density, smooth as-cast finish and good tensiles, you can see why more and more design engineers are turning to Parker Die Castings for their component parts.

Parker has been a leader in die casting for 50 years—an old hand with new ideas. This skill and experience saves you money on *your* component parts. Just call the nearest Parker sales engineer or write the factory direct.

Parker White Metal Company • 2153 McKinley Ave., Erie, Pennsylvania

PARKER

high pressure ALUMINUM and ZINC die castings
POWDERED METAL PARTS



GIANT DOLOMITE SLINGER at Granite City Steel Co. helps prevent slag from burning through furnace bottoms and walls. *It could be a dangerous source of plant fires!* GCS prevents fires by powering the machine with fire-resistant Pydraul hydraulic fluid—a good example of the progressive safety program at the "Steel Center of Mid-America," Granite City Steel Company.

Pydraul Protects Hydraulic Operation at Granite City Steel

At Granite City Steel, Pydraul is the ideal hydraulic fluid for use in the hydraulically operated *dolomite slinger* shown above. Although this slinger is used at the mouth of open hearth furnaces, there is little danger of hydraulic fire because Pydraul is fire-resistant.

Pydraul's claim to safety and dependability has been proved not only at Granite City but by 275 million hours of fire-safe operation in plants everywhere.

Pydraul gives you more than safety. You can be sure of long equipment life with low maintenance . . . because Pydraul lubricates like a premium petroleum oil. You'll save money on fluid make-up, too! Pydraul is reclaimable—you can return spillage to the system, use it again and again.

If your hydraulic equipment is near hot metal, electrical contacts, open flame or other heat sources, you may be taking a needless fire risk. Your Monsanto representative will be happy to show you how easy and economical it is to convert to a fire-safe Pydraul system.

Write for Pydraul F-9 booklet. Organic Chemicals Division, MONSANTO CHEMICAL COMPANY, Dept. PYD-3, St. Louis 1, Missouri.

Pydraul: Reg. U. S. Pat. Off.

Pydraul F-9—first and only hydraulic fluid listed by Underwriters' Laboratories, "In respect to fire hazard, Pydraul F-9 is rated by Underwriters' Laboratories, Inc., 2 to 3 in a class much less flammable than paraffin (Petroleum) oil, according to a schedule in which Ether is rated 100; Gasoline 90-100; Alcohol (ethyl) 60-70; Kerosene 30-40; Paraffin Oil, 10-20."

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MONSANTO

Where Creative Chemistry Works Wonders For You

SHIMS

BRING YOUR SHIM PROBLEMS TO EXPERIENCED SPECIALISTS

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Only LAMINATED SHIM COMPANY Offers These Efficient, Economical Solutions:

THE LAMINUM® SHIM

SIMPLY PEELS FOR ADJUSTMENT

Made up of from 3 to 63 layers of .002 or .003 inch brass or steel, metallically bonded together over their entire surfaces. No dirt between layers. Peels with penknife.

THE LAMISOL® SHIM

FOR QUICK, ASSEMBLY LINE USE

The laminations of the LAMISOL® Shim (in brass) are temporarily joined by spot-soldering on the edges. Gauges and number of laminations within one shim are unlimited.

PACKAGED SHIM STOCK

READY FOR EASY USE, WITHOUT WASTE

Thin gauge 6" x 100" rolls feed through package slots. Heavier gauges in flat envelopes. Available from your Industrial Distributor.

LAMINUM® and LAMISOL® Shims are also made of ALUMINUM; layers are .003".

FLASH! *LAMINUM® now available in STAINLESS STEEL with layers of .002" or .003".*

LAMINATED SHIM COMPANY, INC.

SHIM HEADQUARTERS SINCE 1913

Check Our Stampings Division For Your Stamped Parts Requirements

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Please send me more information on:

☐ SHIMS ☐ STAMPINGS ☐ BOTH

☐ *We'd like to discuss our problem with one of your Sales Engineers.*

NAME_____ TITLE_____

COMPANY_____

STREET_____

CITY_____ ZONE_____ STATE_____

passage is opened in 0.002 sec from inlet to outlet ports with an equivalent orifice of $\frac{5}{32}$ in. dia. This is done by the ram moving forward and shearing and trapping the diaphragm, as a single piece of metal. Only $\frac{1}{2}$ amp electrical current is required to fire the explosive squib. This new standard model has a maximum operating pressure of 5,000 psi and proof pressure of 10,000 psi. Conax Corp., 7811 Sheridan Drive, Buffalo 21, N. Y.

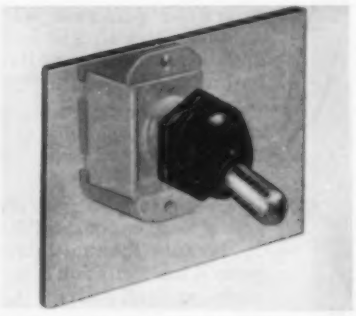
For more information—
Circle 67, inside back cover

Tension Compression Liquid Spring

This liquid spring has a single piston with push-pull spring action. Up to 1040 cycles per minute have been achieved. The housing for the spring is $1\frac{5}{8}$ x $8\frac{1}{2}$ in. long.

This spring has 1100 lb preload and 11,000 endload. Taylor Devices, Inc., 188 Main St., N. Tonawanda, N. Y.

For more information—
Circle 68, inside back cover



Boots for Toggle Switch

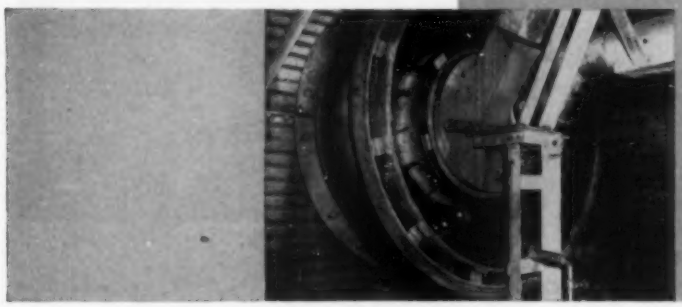
Constructed with an integral hex-nut, these boots can be tightened with ordinary pliers. They are made of silicone rubber. The boots will withstand temperature variations from

(Continued on page 292)

How designers use Porcelain Enamel to reduce costs

Porcelain Enameled pump cylinder wears longer and costs less than special alloys.

Pump plunger employed in oil field operations. Porcelain Enamel is more durable, reduces field service.



Spout for rotating dryer resists corrosion, abrasion and thermal shock because it is Porcelain Enamel.

Porcelain Enamel has proved to be an effective aid to designers in reducing costs. In a variety of ways, its unique properties are employed to effect savings in manufacturing and materials expense.

REPLACES COSTLY MATERIALS. Porcelain Enamel provides a non-porous, inorganic, glass-hard surface that makes it ideal for service where corrosion, abrasion and/or high temperatures prevail. Consequently, Porcelain Enamel can frequently replace costly high alloy or other metals.

REDUCES WEIGHT. The intimate fusing of the inorganic coating to the base metal materially increases the strength and rigidity of the product, thereby permitting weight-reduction in many of its applications. Its thermal-shock resistance makes thinner sections possible.

REDUCES FIELD SERVICE. A very practical advantage provided by Porcelain Enamel is reduction in field service. Where conditions of rust, corrosion, abrasion, high temperatures or thermal shock prevail, Porcelain Enamel resists attacks that would otherwise call for repairs and field service to the equipment. This not only saves money for the manufacturer, but also can be used as a powerful sales advantage.

Are you interested in knowing more about these benefits provided by Porcelain Enamel? We'll be glad to help you get the specific information you want. Let us know your problem, and we'll put you in touch with Porcelain Enamel Manufacturers, qualified to advise you.

Lifetime PORCELAIN ENAMEL
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Please send me design information about PORCELAIN ENAMEL for possible application to_____
(type of product)

Name_____

Company_____

Address_____

NEW CRAMER INTERVAL TIMER features ¼ of 1% of full-scale repeat accuracy, offers wide time-range selection.

New automatic reset interval timer

Eleven full-scale time ranges—15 seconds to 24 hours—give new Cramer Type 241 versatility and precision.

Increased accuracy and operating convenience, a wide selection of time ranges, and lower costs to users are key features of the new Cramer Type 241 automatic reset interval timer.

The new Type 241 timer provides push-button starting and automatic shut-off after a predetermined time interval for a wide variety of electrically-operated equipment such as washing machines, mixers, ovens, tumbling and plating equipment, and laboratory and test equipment. Here's what it offers:

Wide selection of time ranges — 11 full-scale time ranges available ranging from 15 seconds to 24 hours.

Heavy-duty contacts — rated at 15 amperes, non-inductive load, provide capacity to handle high inrush currents.

High overall accuracy — within ± ¼ of 1% of full scale, exclusive of human setting errors.

High repeat accuracy—within ± ¼ of 1% of full scale.

Easy-to-read 3-inch dial — a fully enclosed high-visibility, black-on-white dial features 300° scale, black setting pointer and red progress pointer for easy reading and accurate setting.

Easy interval setting—large setting knob, concentric with red start button, allows rapid setting to precise time intervals. And, important at longer time ranges, setting may be changed while unit is running.

You'll find complete data on the new Type 241 timer in Bulletin PB-211. Write for your copy today. The Cramer Controls Corporation, Box 7, Centerbrook, Conn. 6.4

OUR NEW NAME

The R. W. Cramer Company has become The Cramer Controls Corporation. The reason? Simply that we outgrew the old name. We're still specialists in precision time control. And, you'll find us today ready and willing to serve you with better products and faster deliveries than ever before.

The Cramer Controls Corporation, Centerbrook, Conn.

CRAMER CONTROLS
CORPORATION

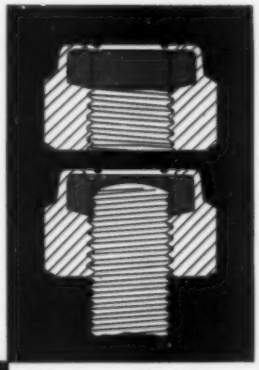
What's special about this STOP NUT?

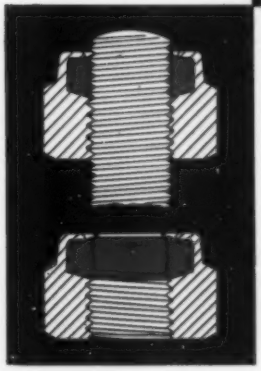
Several things make this nut unusual. For instance, you can "stop" it at any position on the threaded length of the bolt . . . or wrench it tight against the work where it protects bolt threads against corrosion and prevents liquid leakage. No matter where you leave it on the bolt, it will remain tight in that exact position, even though you subject it to heavy vibration and shock loads. But use a wrench on it and it comes off as easily as it went on. The red locking collar is nondestructive—does not gall bolt threads or remove plating. You can remove it and re-use it again and again.

What gives it its grip?

1 The locking collar is unthreaded and elastic. It has an inside diameter smaller than the major diameter of standard bolts.

2 The bolt impresses a mating thread into the collar and the resulting compressive forces exert a constant friction grip on the bolt. . . .





3 and exert a downward thrust bringing the lower flanks of the bolt thread into firm metal to metal contact with the matching nut threads, eliminating normal axial play.

4 Nut is removable and reusable . . . the Red Elastic Collar retains its grip after repeated usage.

Will it hold under ALL conditions?

The locking principle of the Elastic Stop® nut has been tested and proved by over 25 years of actual field service. Elastic Stop nuts are used on locomotives . . . and pile drivers. They fasten hedge shears and harvesters, drilling rigs and washing machines, trucks and roller skates. And no Elastic Stop nut customer has ever stopped using them because of unsatisfactory performance.

What about sizes and materials?

Elastic Stop nuts are available from a watchmaker's 0-80 all the way to 4"—in materials that include stainless steel, brass, aluminum and other alloys. Protect your product with "fastener insurance." Try Elastic Stop nuts on trouble spots, whether to protect expensive heavy equipment from costly downtime or to guarantee the accuracy of delicate electrical equipment by maintaining precision adjustments. We'll supply free test samples.

ESNA® TRADE MARK

ELASTIC STOP NUT CORPORATION OF AMERICA

Dept. N82-84 2330 Vauxhall Road, Union, N. J.

Please send the following free fastening information:

☐ ELASTIC STOP nut bulletin

☐ Here is a drawing of our product. What self-locking fastener would you suggest?

Name_____ Title_____

Firm_____

Street_____

City_____ Zone____ State_____

This New PIONEER Coolant Pump gives you Important Advantages

1. Totally enclosed motor, with extra-heavy shaft and heavy-duty ball bearings.
2. Handles abrasives or chips without injury to the pump.
3. Will pump down to 1 1/16"; self-priming to 1" liquid level.
4. Permits clean-out of machine sump with minimum time and labor.
5. Interchangeable with any make pump with standard mounting dimensions.
6. Sealless design with no metal-to-metal moving parts.
7. Can be furnished with any desired electrical characteristics.
8. Three optional outlets: left external, right external, center outlet through mounting flange. The latter permits compact, clean-cut design of machine with no exposed piping.

Pioneer offers more than 400 models of impeller-type and positive displacement pumps to meet every coolant pump requirement; or we will develop designs for specific applications. Our application engineers will welcome the opportunity to discuss your pump requirements with you.

Send for our illustrated booklet covering the basic Pioneer designs in both impeller-type and positive displacement pumps.

PIONEER PUMP DIVISION
DETROIT HARVESTER COMPANY
Sales Office: 5450 West Jefferson Ave., Detroit 9, Michigan
Plant: Paris, Kentucky

—125 F to 500 F and remain unaffected by saltwater, acids or ozone. Automatic & Precision Mfg. Co., 252 Hawthorne Ave., Yonkers, N. Y.

For more information—
Circle 69, inside back cover

Miniature Terminal Lugs and Rivets

These terminal lugs and rivets are designed for packages in instrument, electronic, and printed circuit applications. They are 24 carat gold plated. A 3/32 in. dia rivet, also gold plated, has been designed to fasten the lug to a printed circuit or other electronic part. Circon Component Co., Santa Barbara Municipal Airport, Goleta, Calif.

For more information—
Circle 70, inside back cover

Rotary Latch

For use on hinged or removable parts, such as electrical control panels, covers, inspection doors, access panels, machinery doors, this latch is made of steel, cadmium plated. It consists of four parts: latch-screw, shim plate, anchor block and latch-nut. The latch is assembled on the panel or door only. Three standard sizes are currently available. Scovill Mfg. Co., 99 Mill St., Waterbury, Conn.

For more information—
Circle 71, inside back cover

Oil Cooled Asbestos Friction Material

The friction material for oil cooled power transmission equipment contains no metallic particles or wires and is lighter and less expensive than metallic friction disks. Clogging small ports in the oil system with metal particles is avoided. Flexibility to meet specific applications can be achieved by varying the weave, the impregnating ingredients, and the processing treatment.

The new material is designed to be bonded to metal plates with thermosetting resins and assembled in oil-cooled units alternately with metal pressure plates. The thickness of the material ranges from a minimum of 0.030 in. to a maximum of 0.090 in.,

(Continued on page 297)

LUBRICATION A PROBLEM?
why not try *PUREBON . . .

* CARBON-GRAPHITE ESPECIALLY DESIGNED FOR MECHANICAL APPLICATIONS

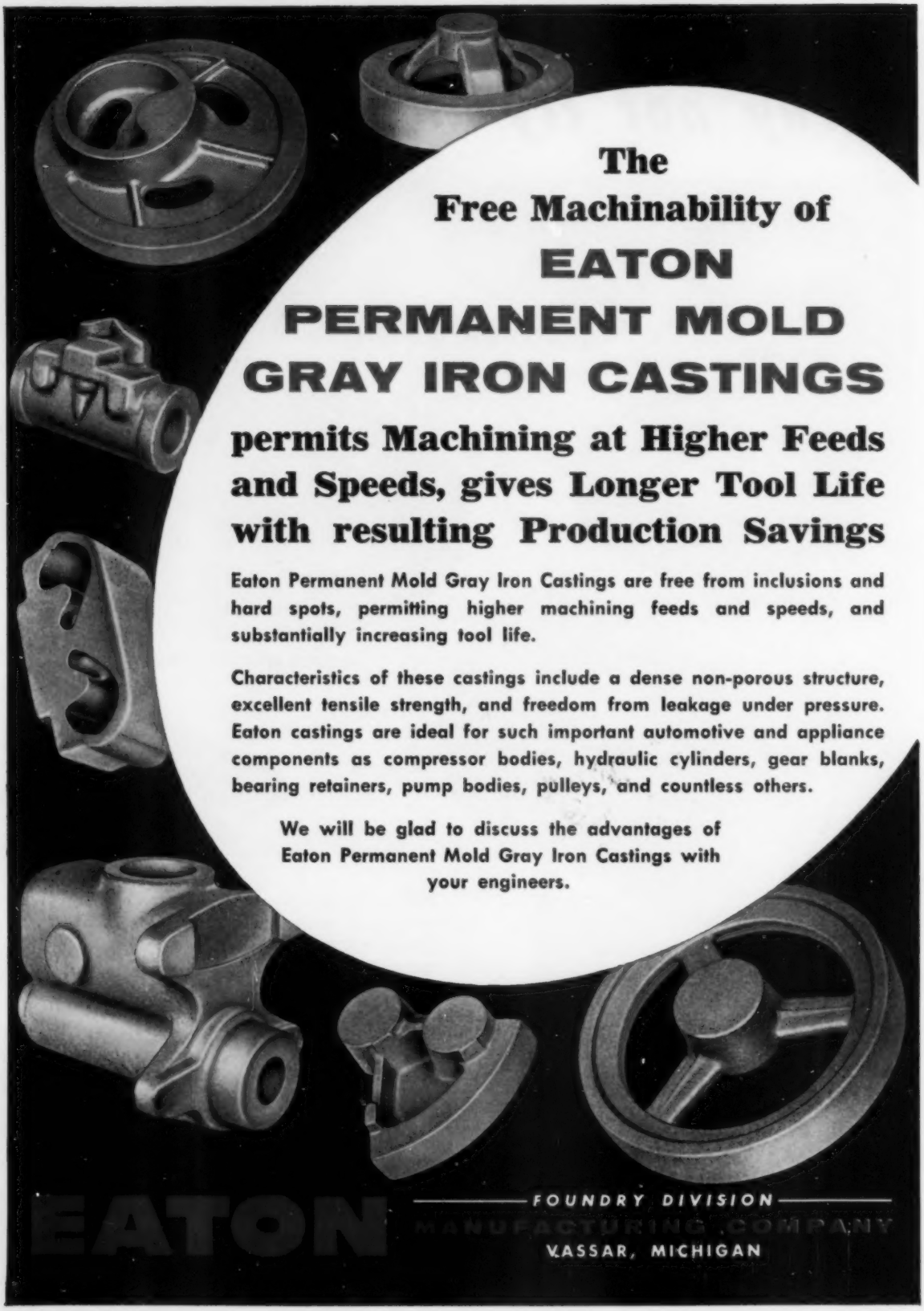
PROPERTIES OF PUREBON

1. Molded to size—for many applications.
2. Readily machineable to any intricate shape.
3. Chemically inert—non-toxic, resists attack by most chemicals.
4. Dimensionally stable — does not warp or distort at high temperatures.
5. Light weight — low cost where molded to size.
6. Low coefficient expansion — good electrical conductivity.

Purebon is the ideal solution to many knotty problems facing designers today involving sliding or rotating parts where lubrication is difficult or impossible. Many grades of Purebon can be run dry at temperatures as high as 1000°F. Water, acids, gasoline and jet fuels make ideal lubricants for many grades of Purebon. (*Whatever your problem, there is a grade of Purebon for its solution.*)

For complete information about Purebon, write for new Bulletin No. 55.

PURE CARBON CO., INC.
448 HALL AVENUE **ST. MARYS, PA**


The
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EATON
PERMANENT MOLD
GRAY IRON CASTINGS
permits Machining at Higher Feeds and Speeds, gives Longer Tool Life with resulting Production Savings
Eaton Permanent Mold Gray Iron Castings are free from inclusions and hard spots, permitting higher machining feeds and speeds, and substantially increasing tool life.
Characteristics of these castings include a dense non-porous structure, excellent tensile strength, and freedom from leakage under pressure. Eaton castings are ideal for such important automotive and appliance components as compressor bodies, hydraulic cylinders, gear blanks, bearing retainers, pump bodies, pulleys, and countless others.
We will be glad to discuss the advantages of Eaton Permanent Mold Gray Iron Castings with your engineers.
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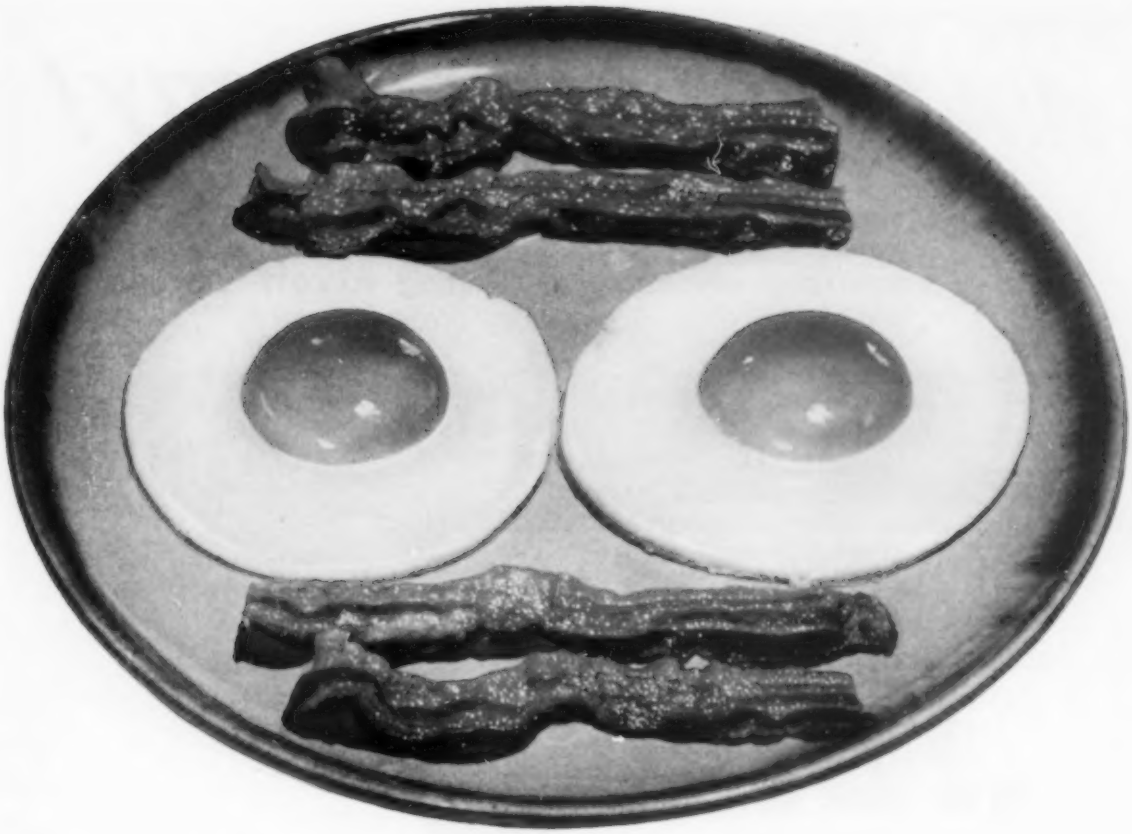
VASSAR, MICHIGAN



. . . a combination that's hard to beat!

Laminated plastics . . . for a combination of properties that *can't* be beat

SYNTHANE is a favorite material among engineers, designers, and product-conscious executives because it possesses a combination of many properties. It is light in weight, strong; has high dimensional stability, excellent electrical properties and chemical resistance. It's also easy to fabricate.

Synthane makes excellent ball bearing retainers. High dimensional stability, wear resistance and non-galling properties keep bearings humming smoothly at 100,000 rpm and up! Synthane's light weight minimizes the effect of any eccentricities, provides lower starting torques, less bearing weight. The Synthane plant has facilities for producing practically every type of laminated plastic retainer known.

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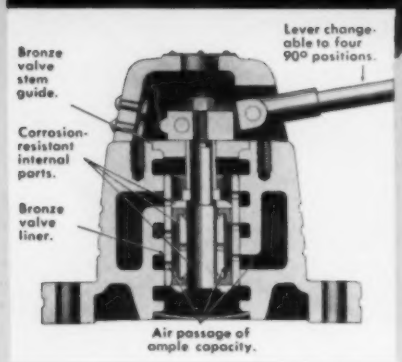
AIR POWER CAN BE COSTLY!

Eliminate breakdown and reduce maintenance by choosing Rivett Valves!

LONG LIFE ASSURED BY SIMPLE, COMPACT DESIGN


Lever changeable to four 90° positions.
Bronze valve stem guide.
Corrosion-resistant internal parts.
Bronze valve liner.
Air passage of ample capacity.

– at new low prices!

Flexibility for designing any circuit

Be confident of the continuous, uniform control of air by using any of the complete line of Rivett Air Valves. Design assures easy operation, long life — precludes need of adjustment—prevents leakage. Readily disassembled for servicing or modification.

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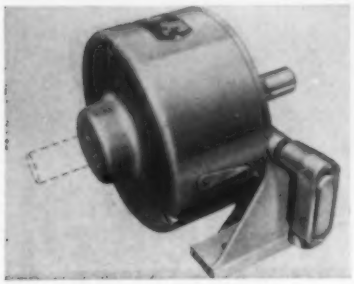
in increments of 0.010 in. One-piece, full ring diameters are available up to 12 in. OD. Plates of unlimited diameters for this type of service can be obtained by using segmented pieces. The material is available in rings, bands and cores. Thermoid Co., Trenton, N. J.

For more information—
Circle 72, inside back cover

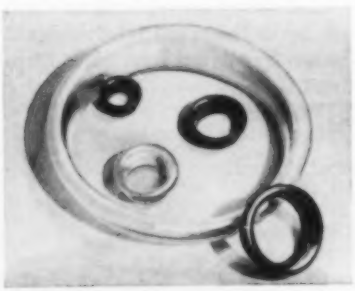


Disc-Type Magnetic Brake

This disc-type brake can be mounted separately from a motor because of its foot mounting. Two models are available: one with its own self-contained bearings and shaft for applications where a coupling is used between machine and brake; the second without shaft, to permit the extension of the machine drive directly into the brake.

Ratings available are 3, 6, 10, 15 and 25 ft-lb, continuous duty; 3, 6, 10, 15, 25 and 35 ft-lb, intermittent duty. Reuland Electric Co, Alhambra, Calif.

For more information—
Circle 73, innside back cover

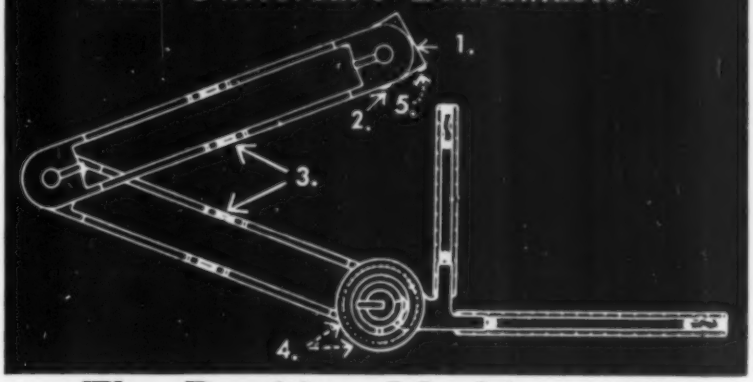


Rolled Nylon Washer

These washers are slipped over the bolt, screw, rivet or nail and when pressure is applied to tighten the fastener, the washer "cold-flows" around

(Continued on page 300)

Exclusive Design Details
with Universal's Boardmaster



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1. **HINGE ANCHOR** — Raises machine without strain or loss of tension to position large sheets of paper or brush off erasures.
2. **LEVELING NUT** — For ease in flattening scales to the drawing surface. Adjusted from normal drafting position in front of the board.
3. **CENTER ARM TENSION NUTS** — For easy replacement or adjustment of bands IN THE FIELD. No return to factory — no down-time.
4. **NYLON FEET**—Highly wear-resistant! Keep scales lying flat!
5. **KEY WRENCH CLAMP** — Easy to turn. Large, full-grip design. The most rigid and secure clamping action, with maximum pressure.

Ask your dealer about these and MANY more Boardmaster advantages — or write direct!

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DRAFTING MACHINE CORPORATION
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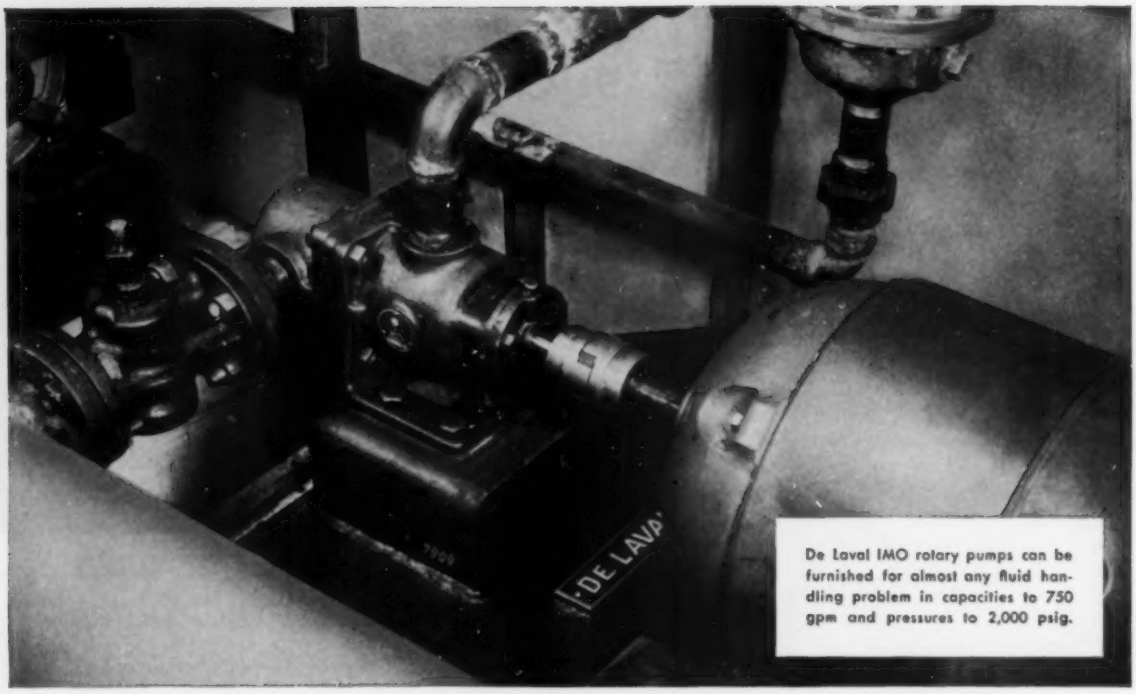


De Laval IMO rotary pumps can be furnished for almost any fluid handling problem in capacities to 750 gpm and pressures to 2,000 psig.

What to Look for in a Rotary Screw Type Pump

By W. J. MONCON, *Assistant Chief Engineer*
De Laval Steam Turbine Company

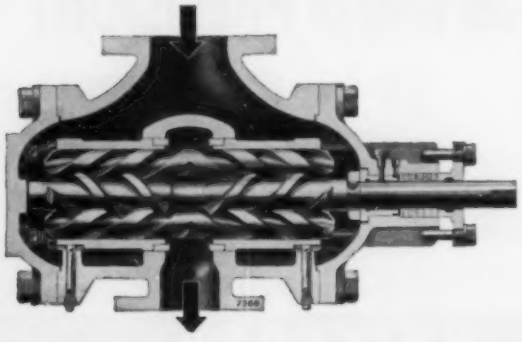
A sound knowledge of design, and how it affects performance, is the best insurance a buyer can have that he will get the pump he needs. This brief analysis of the IMO, a rotary three-screw pump manufactured by the De Laval Steam Turbine Company, will give you some of the necessary facts.

What qualities should you look for in a rotary type pump? It must, of course, meet specified capacities and pressures. But, it must also be efficient, operate quietly, stay on the job.

The axial flow of a screw type pump, and the resulting low inlet losses for any given pump speed, are important benefits that should be considered in making pump selections. The absence of timing gears and other mechanical features of construction also enable the De Laval IMO pump to operate at direct-connected motor and turbine speeds . . . to handle viscous liquids and high suction lifts.

One of the most important features of the IMO pump is the hydraulic turning of the idler or sealing rotors. The central or power rotor is the pumping element; the liquid pumped turns the sealing rotors.

A screw type pump is well suited for applications where pulsation-free flow is desirable. The axial flow of the liquid without trapping and the unique thread form which keeps closures fluid-tight contribute to quiet operation of the IMO pump.



This is a cross-section of the De Laval IMO Series A322A, a positive displacement rotary screw type pump.

Catalog LS gives useful application and specification data on the IMO pump. An article titled, *Rotary Pumps, Basic Considerations in Their Application*, contains a description of rotary pumps in general. For these publications, write on your company letterhead to De Laval Steam Turbine Company, 801, Nottingham Way, Trenton 2, New Jersey. DL-301

Handles coated with vinyl-foam for

Smooth grip...

cushioned grasp

Coating of foamed vinyl plastisols makes these scissors more comfortable to use, with a very small increase in cost. Plastisols based on BAKELITE Brand Vinyl Resins formulated by **The Stanley Chemical Company**, East Berlin, Conn., for **John Ahlbin & Sons, Inc.**, Bridgeport, Conn.

. . . and this new comfort makes them easier to sell! Colors are used to add new eye-appeal for further sales-appeal. An additional advantage to the manufacturer is that the application of foamed plastisols based on BAKELITE Brand Vinyl Resins is fast and economical . . . can keep competitively priced products in line with the competition; hand polishing and plating of rough castings can often be eliminated.

Perhaps your product needs a new "handle." Foamed plastisols based on BAKELITE Vinyl Resins may give you a new, lower cost solution to your problem. Color selection is wide allowing for easy visual identification . . . and colors stay true. Plastisols resist moisture, acids and the smooth surface makes the handles virtually dirt proof. Why not investigate foamed plastisols based on BAKELITE Brand Resins today? Write Dept. SS-145.

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BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.

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An Alcoa Aluminum Fastener should be used here!

It's an aluminum awning assembly, worth the lasting strength of Alcoa® Aluminum Fasteners. You avoid galvanic and atmospheric corrosion. You get perfect color match; you get the very highest quality product. Your local Alcoa distributor has a complete stock.

P.S. In this awning assembly, we suggest an aluminum sheet metal screw. One from Alcoa's complete line of aluminum fasteners.

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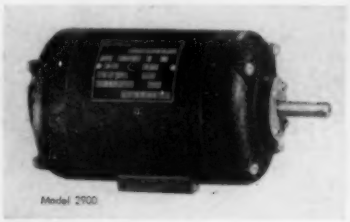
ALCOA ALUMINUM FASTENERS

and under the fastener head. All space between threads and hole are said to be filled. Nyltite Corp. of America, Union, N. J.

For more information—
Circle 74, inside back cover



Fhp Induction Motor

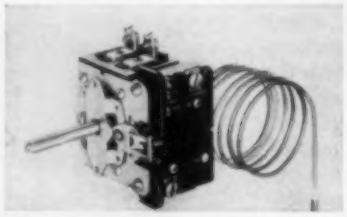
This motor is rated 1/100 to 1/15 hp. Laminations are designed with 24 slots instead of 16 to reduce cogging and increase power output. Design reduces external field. Six and eight-pole motors are available. Howard Industries, Inc., Dept. I.M., Racine, Wis.

For more information—
Circle 75, inside back cover

Subminiature Tantalum Capacitors

These metal-encased capacitors, 0.145 x ⅜ in. long, are available in five different ratings: 80 mfd at 3 v; 50 mfd at 6 v; 25 mfd at 15 v; 15 mfd at 30 v; and 8 mfd at 50 v. P. R. Mallory & Co., Inc., Indianapolis 6, Ind.

For more information—
Circle 76, inside back cover



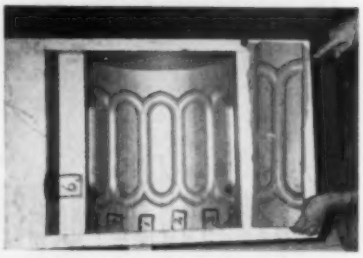
Thermostat Controls Two or More Circuits

An electric thermostat that controls two or more circuits with a single dial makes it possible to disconnect two or more lines when the dial is turned off. This extra duty is accomplished

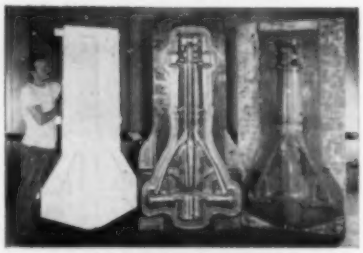
(Continued on page 304)

HYSOL
Plastic Tooling Materials . . .
• Cut Costs
• Save Time
in these applications

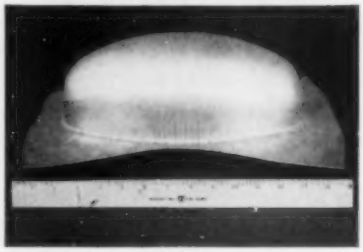
• CORE BOXES •



• KELLER PATTERNS •



• DIE FORMED PART •



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FOR THAT HIGH TEMPERATURE APPLICATION USE

NOELTING

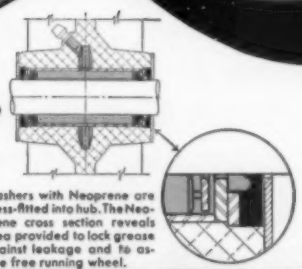
Faultless TRIPLE GREASE SEALED CASTERS

with NEOPRENE VULCANIZED RETAINERS

1 LEAK-PROOF NEOPRENE RETAINER MOLDED AND VULCANIZED ON UPPER BEARING SWIVEL RACEWAY. PATENT PENDING.

2 THRUST BEARING GREASE RETAINER TIGHTLY FITTED AROUND FORMED, HARDENED RACEWAY. CAN BE EASILY REMOVED FOR CLEANING OR INSPECTION.

3 NEOPRENE RING PERMANENTLY ATTACHED TO METAL WASHER AND PRESS FITTED INTO HUB.



Washers with Neoprene are press-fitted into hub. The Neoprene cross section reveals area provided to lock grease against leakage and to assure free running wheel.

FROM 0°F. to 200°F. SWIVEL AND WHEEL BEARINGS OPERATE FREELY— KEEP TRUCKS ROLLING— CUT MAINTENANCE COSTS

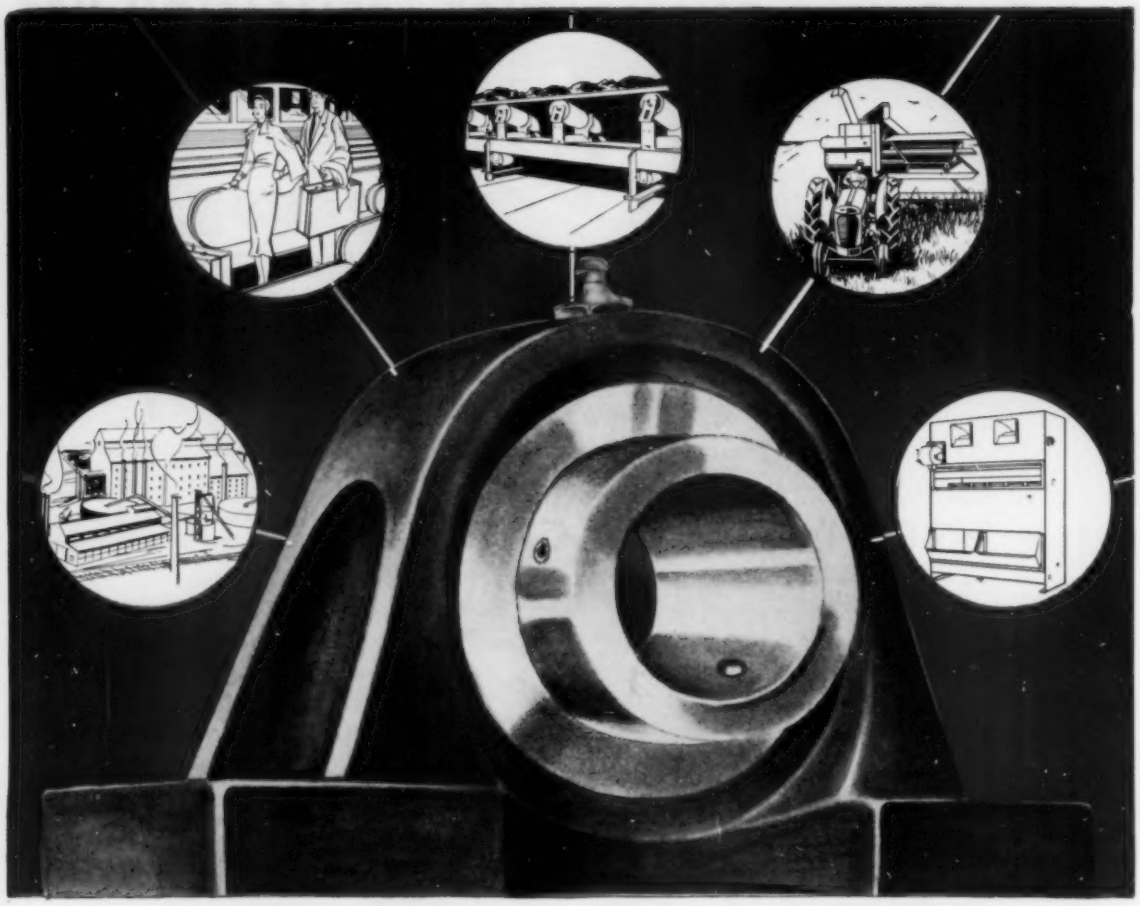
If you have a high temperature problem involving mobile equipment, you should look at the superior features of the Series 900 GS Caster. Formed to fit the main swivel bearing and permanently vulcanized to it, the Neoprene retainer seals in the grease—keeps out dust, dirt, chemicals, water, etc. Prevents oil dripping on floor.

A permanent film of grease, between the Neoprene retainer and top-plate, greatly reduces friction—accelerates swiveling—minimizes "downtime" and plant interruptions. More loads can be moved by one man.

Series 900 GS Caster has Double Ball Bearing Swivel construction with two full rows of hardened, ground and polished large diameter balls in grease sealed, case hardened raceways. Large diameter King pin. Heavy gauge, full drawn steel horn will not bend under maximum rated loads. Wide choice of wheels for loads up to 650 lbs. per caster. For further information on 900 GS Casters write for Bulletin 157-3G, no obligation.

FAULTLESS CASTER CORPORATION, EVANSVILLE 7, INDIANA

Offices in Atlanta, Baltimore, Boston, Buffalo, Chicago, Cleveland, Dallas, Detroit, Grand Rapids, High Point, Indianapolis, Los Angeles, New Orleans, New York, Philadelphia, Portland, Seattle, St. Louis. Canada: Stratford, Ontario.



SEALMASTER

has an important bearing on the performance of machinery you build!

Whether you manufacture farm machinery, air conditioners, textile machinery, conveyors, machine tool equipment, or road machinery, the exclusive combination of features found in SEALMASTER Bearing Units are important to you! One of the most significant trends in industry today is the increased concern for quality. Production schedules can't be kept up when machinery is down for maintenance. No component you build into your product will mean more to its efficient performance than the bearing units carrying the load. You'll want full information on SEALMASTER'S exclusive combination of features and what they mean to the performance of your products.

SEALMASTER BEARINGS A DIVISION OF STEPHENS-ADAMSON MFG. CO., 9 RIDGEWAY AVENUE, AURORA, ILLINOIS

The gears in an automatic nut former have to be tough and strong to withstand heavy, varying loads. Yet, the castings from which they're made should be easy to machine. That's why this gear for a Waterbury Farrel Automatic Nut Former is made from ASTM-50 gray iron with a nominal composition of 1% nickel and .50% molybdenum.

Moly gives cast iron gears higher strength with toughness and good machinability

"To insure a tough, easily machined gray iron for the gears in our Automatic Nut Formers," says Henry C. Griggs, Metallurgist for Waterbury Farrel Foundry & Machine Co., "we specify .50% molybdenum in our ASTM-50 material. The properties of this material contribute importantly to the reputation of Waterbury equipment for accuracy and high speed production under severe operating conditions."

Molybdenum helps to give reliable and reproducible castings — very important factors in consistent performance of gears.

Investigate moly irons. They may be the key to better performance in many of your gear applications.

For the first two in a series of bulletins, "Why Moly Iron," or for technical assistance, write Climax Molybdenum Co., Department 61, New York 36, N. Y.

CLIMAX MOLYBDENUM

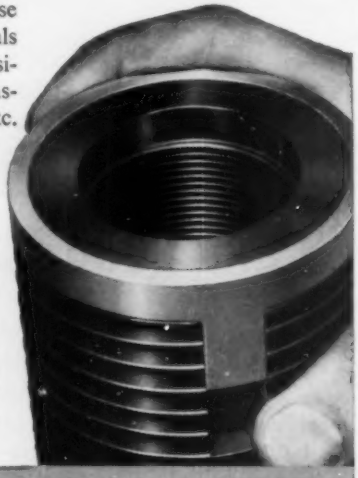
SUB MINIATURES

Now you can get sub-miniature "key-locking" inserts in 0, 1, 2, 3, and 4 thread sizes. Sub-miniatures, made only by Kelox, offer design engineers the opportunity for making small assemblies even smaller and lighter. Identical to regular Kelox inserts, these new "key-locking" sub-miniatures will not rotate or loosen with vibration . . . provide maximum holding power . . . save weight and space.

SAVE WEIGHT...
SAVE SPACE
with KELOX®

The Kelox system of threaded and tapped inserts offers the ultimate in weight- and space-saving design. Maximum holding power between parent and bolted piece is obtained because patented "key-locking" produces no stress concentrations and permits complete use of external threads. Independent laboratory tests have verified that "key-locking" successfully withstands application of maximum torque.

Low cost, easy-to-install Kelox inserts are available for internal thread sizes from 0 to 3 inches. Made of many materials (alloy steel, corrosion-resistant steel, brass, aluminum alloy, monel, etc.), Kelox inserts are also available with thin or thick walls for use with various materials —aluminum, magnesium, "pot" metal, plastic, titanium, steel, etc.



EXTRA LARGE

For big assemblies, Kelox extra large inserts (up to any specified diameter) give unmatched performance—performance that verifies the soundness of Kelox exclusive "key-locking" principle. Only Kelox offers you a positive, non-rotating insert that does not break down protective coatings like ceramic . . . requires no special threads . . . gives maximum reduction of space and weight.

KELOX

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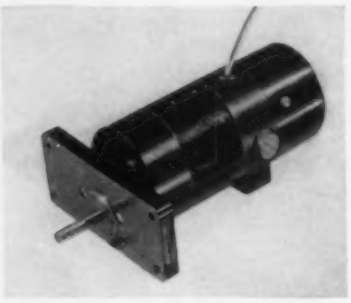
Toronto 18, Canada

4274

by a switch, cam-operated from the dial shaft.

Standard temperature range is from 40 to 550 F. The control is rated 30 amp, 120-240 v ac, non-inductive load. Motor rating is 14 amp, 120-240 v ac, running current. Wilcolator Co., Elizabeth, N. J.

For more information—
Circle 77, inside back cover



Constant Speed D-c Motor

A governor-controlled, continuous duty, d-c drive motor designed for high shock and vibration applications has a cast aluminum housing. A gear train reduces shaft speed from 7344 to 1836 rpm. Output speed is constant within ± 0.3 per cent, with loads varying from 1/12 to 1/30 hp, input voltage varying from 22 to 28 v, and ambient temperatures varying from — 65 to 140 F. Complete unit weighs 2½ lb, and diameter is 2⅜ in. John Oster Mfg., Racine, Wis.

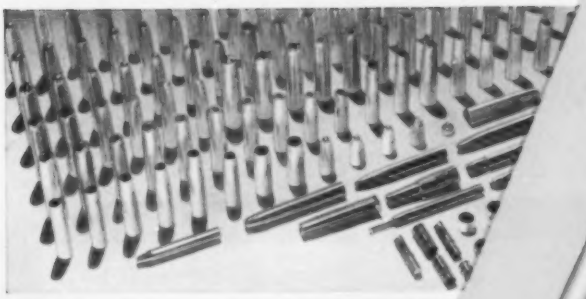
For more information—
Circle 78, inside back cover

Centrifugal Blowers

This centrifugal blower, powered by a permanent magnet motor, is designed for dissipating the heat generated by electron tubes, circuit com-

(Continued on page 308)

Deep Drawn Metal Parts



- SHELLS
- CANS
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- FERRULES
- SPECIAL DRAWN SHAPES

Parker "Jotter"* ink cartridge fully drawn on one machine for maximum economy

● Secret behind the greater writing capacity of the Parker Pen Company "Jotter" ball point is this unique, king-size ink cartridge measuring $3\frac{9}{16}$" in depth.

Most part makers would have to produce this cartridge in stages, accomplishing a partial draw on one machine and completing it on another. Extra annealing and superfluous material handling introduce greater costs.

Sylvania has, at its Connecticut plant, multiple-plunger equipment to produce this complete draw in one continuous operation, on one machine, *at a saving to the customer*.

Sylvania's Parts Division offers you facilities for all eyelet and special formed parts—backed by 23 years' experience in helping manufacturers reduce their parts costs.

High-speed, multiple-plunger eyelet machines range in capacity from the smallest eyelet to a 3-ounce can drawn from a 5" blank. Parts may be drawn in all materials ranging in thickness from 0.007" to 0.055". The Metal Stamping section of Sylvania's 4-way parts service is also equipped with four-slides, vertical presses, and special Sylvania-designed equipment to meet all your requirements for small to medium size precision stampings, and wire and ribbon forms. Write for complete information.

*Registered Trade-Mark of the Parker Pen Company

PARTS DIVISION

metal stamping | special wire | molded plastic | electronic parts

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SYLVANIA ELECTRIC PRODUCTS, INC.
Parts Division,
Warren, Pennsylvania

LIGHTING • RADIO • TELEVISION • ELECTRONICS • ATOMIC ENERGY

TDA® BRAKES

if it rotates...we can control it!

Ultra-Simplicity in a new, light brake of exceptionally high torque output!

new "VEE" brake

This new brake offers important control advantages to virtually every industry. It is already proving its worth in many demanding applications in the farm equipment and materials handling fields.

The "VEE" Brake is extremely simple in design—only six parts. A new design concept achieves an exceptionally high torque output with extremely simple installation. The unique wedge action makes it self-energizing in both directions. Result: a light-duty, easily assembled brake with stopping power to spare.

Cooler running is assured with a proportionately greater drum-swept area. This combined with bonded, high-density linings provides longer life. Actuation is mechanical and may be power-applied.

Simple installation and adjustment! The "VEE" Brake can be completely assembled and then inserted in its enclosure. This eliminates "blind" assembly of the parts. Adjustment can be accomplished by altering the length of the pull rod. Maintenance is quick and easy . . . just minutes to take apart and reassemble.

For expert consultation on your brake problems, contact the Timken-Detroit® Brake Division.

For every industrial, agricultural or automotive application where braking is required!

TDA Plants at: Detroit, Michigan • Oshkosh, Wisconsin • Utica, New York
Ashtabula, Kenton and Newark, Ohio • New Castle, Pennsylvania

TIMKEN Detroit BRAKES
ROCKWELL SPRING AND AXLE COMPANY
ASHTABULA, OHIO
the Accepted TDA Standard

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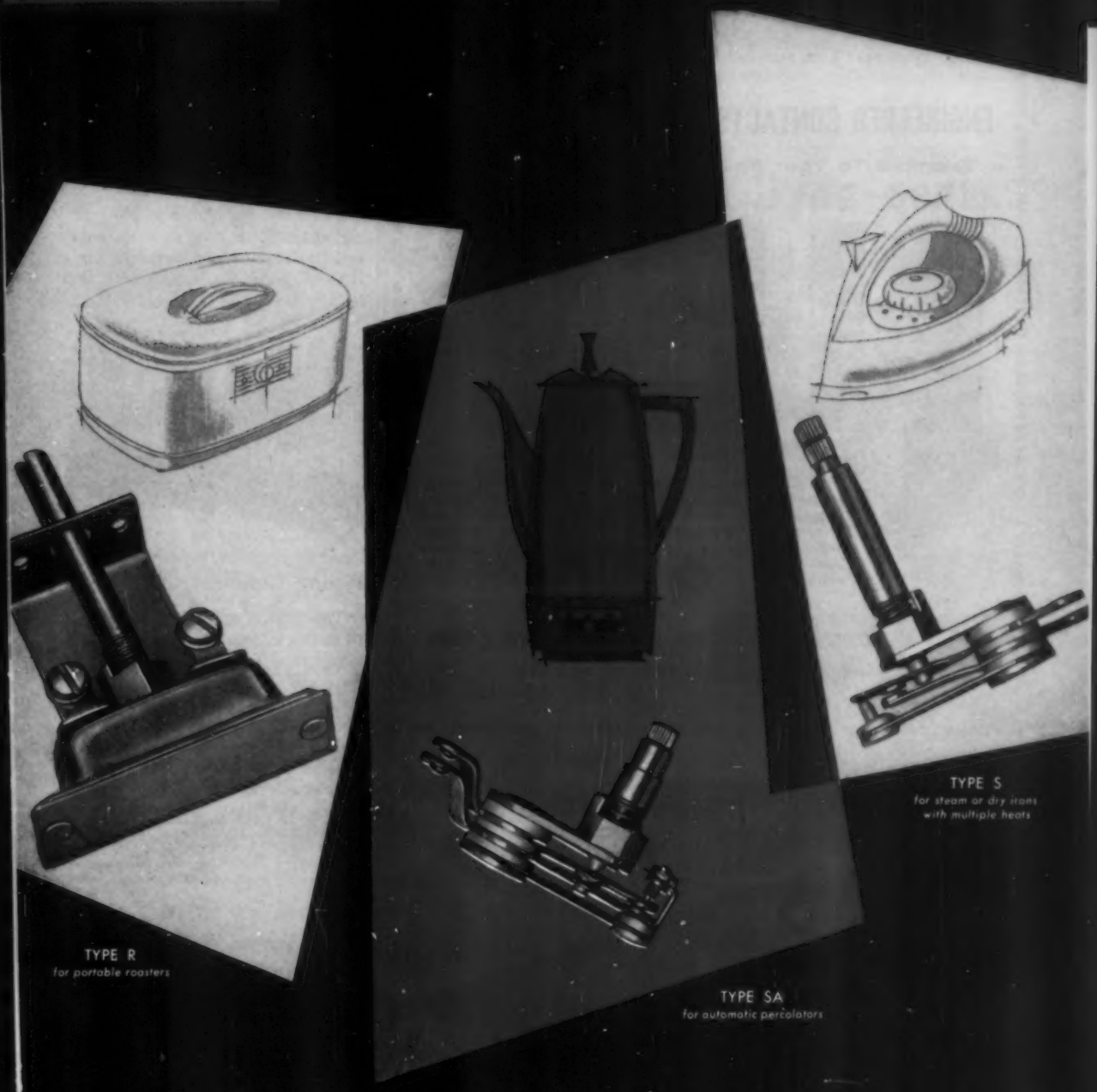

TYPE R
for portable roasters

TYPE SA
for automatic percolators

TYPE S
for steam or dry irons with multiple heats

THERMOSTATS

to whet a designer's imagination . . .

With competitive conditions ahead, you're probably reappraising your product. Or designing a new one. Either way, with Stemco thermostats on the job there's every chance you'll improve performance . . . solve production headaches . . . lower costs.

No other line of bimetal thermostats has as many different styles in production. So if you want close control, compactness, light weight—you'll find them all in Stemco thermostats. Combined with Stevens application engineering service, you profit from important savings of being able to use a production line Stemco thermostat for your special needs.

Let's match our experience and enthusiasm against an hour of your time. A card or call will bring our representative on the double.

STEMCO thermostats

sensitive • close control
quick acting • positive acting
snap acting • shock resistant
light • compact • adjustable
non-adjustable
open type
hermetically sealed

STEVENS

manufacturing company, inc.
Mansfield, Ohio

NEY'S SMALL PARTS PLAY A BIG PART IN PRECISION INSTRUMENTS • NEY'S SMALL PARTS

ENGINEERED CONTACTS, SLIP RINGS & ALLOYS

Supplied To Your Specifications By . . .

NEY

Ney offers wide experience in the development of sliding contacts, slip rings and assemblies, commutator segments and assemblies, brush and brush holder assemblies, and precious metal resistance wire. Call or write the Ney Engineering Department for consultation on any problem involving the use of precious metals to improve your products.

THE J. M. NEY COMPANY, P.O. BOX 990, DEPT. J, HARTFORD 1, CONN.

Specialists in Precious Metal Metallurgy since 1812

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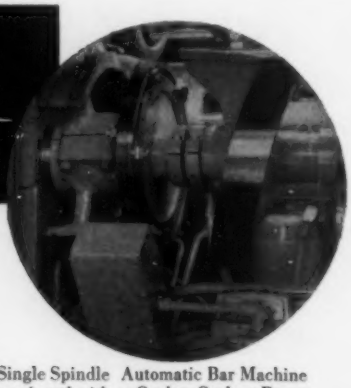
SPLIT SECOND

COOLANT FLOW

with Ruthman GUSHER Coolant Pumps



Illustrated is a Cleveland Dialamatic Single Spindle Automatic Bar Machine equipped with a Gusher Coolant Pump.

Model 5-P 3

Your Gusher Coolant Pump is always primed and ready to deliver coolant instantaneously. There is no lag — no waiting for the flow to start — and you can easily regulate the volume from a trickle to full capacity.

Pre-lubricated ball-bearings, electronically balanced rotating shaft, and totally enclosed dustproof motor assure you also of long trouble-free life for your Gusher Coolant Pumps.

THE RUTHMAN MACHINERY CO.

1818 READING ROAD CINCINNATI, OHIO

ponents, and other similar equipment mounted in confined enclosures. Units are available for either clockwise or counter-clockwise rotation in several sizes.

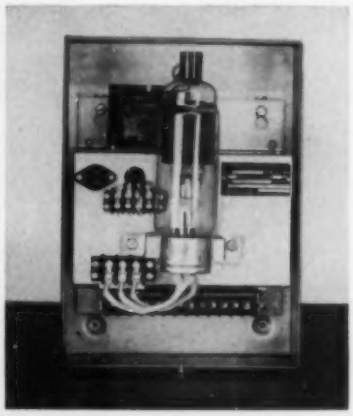
Voltages range from 6 to 115 v dc. Air volume (at zero static pressure and 70 F) for a typical unit is 20 cfm. Barber-Colman Co., 1400 Rock St., Rockford, Ill.

For more information—
Circle 79, inside back cover

Piping Compensator

This unit is made to take care of all strains in steam, air, hydraulic and refrigeration pipe lines. It consists of two ball seats individually spring seated so that movement can take place in all directions including unlimited traverse expansion. They are available in sizes from ½ to 6 in., in any suitable length. Rotherm Engineering Co., Inc., 7280 W. Devon Ave., Chicago 31, Ill.

For more information—
Circle 80, insideback cover



Fhp Motor Speed Control

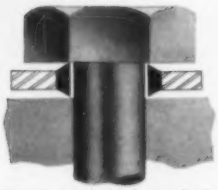
This line of electronic adjustable speed drives includes both full-wave and half-wave units and spans a rating range from 1/50 to ¾ hp. They

(Continued on page 312)

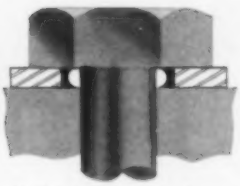
Precision Dyna-seal

Leak-proof Precision Dyna-seals

solve countless sealing problems



Dyna-seal before bolt head is drawn down



Bolt head drawn down —with pressure applied

How pressure forces sealing lips against surfaces

Vibration Proof, Lock Washer Action

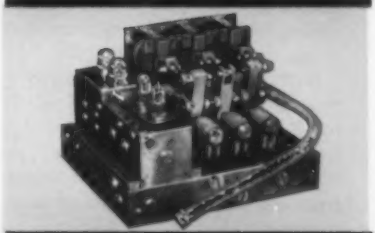
Dyna-seals bring to an end an age-old leakage problem on face-to-face connections. They provide a positive and economical liquid or vapor seal against a steady or pulsating pressure of up to 10,000 P.S.I.

The practical Precision Dyna-seal is an easy-to-handle one piece unit, consisting of a flared rubber sealing ring, heat and pressure bonded to a steel washer. No grooves or special machining required. Permanent, leak-proof sealing without excess stress. (Bolting torque is reduced.) Simplicity of the Precision Dyna-seal greatly reduces tooling and assembly costs.

Dyna-seals give exacting performance under bolt and rivet heads, cap nuts, flanges or special fittings. Let a Precision engineer demonstrate the Dyna-seal cost and labor saving advantages to you. Write today!

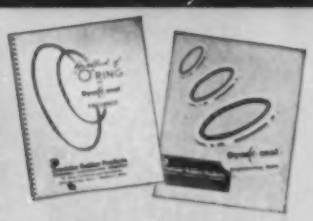
Typical Dyna-seal Applications

Dyna-seals provide uncompromising sealing performance under bolt heads of the nuclear submarine Seawolf periscope mounting.



30 Dyna-seals solve plug-leakage problem on The NATCO Hydraulic Control Unit manifold.

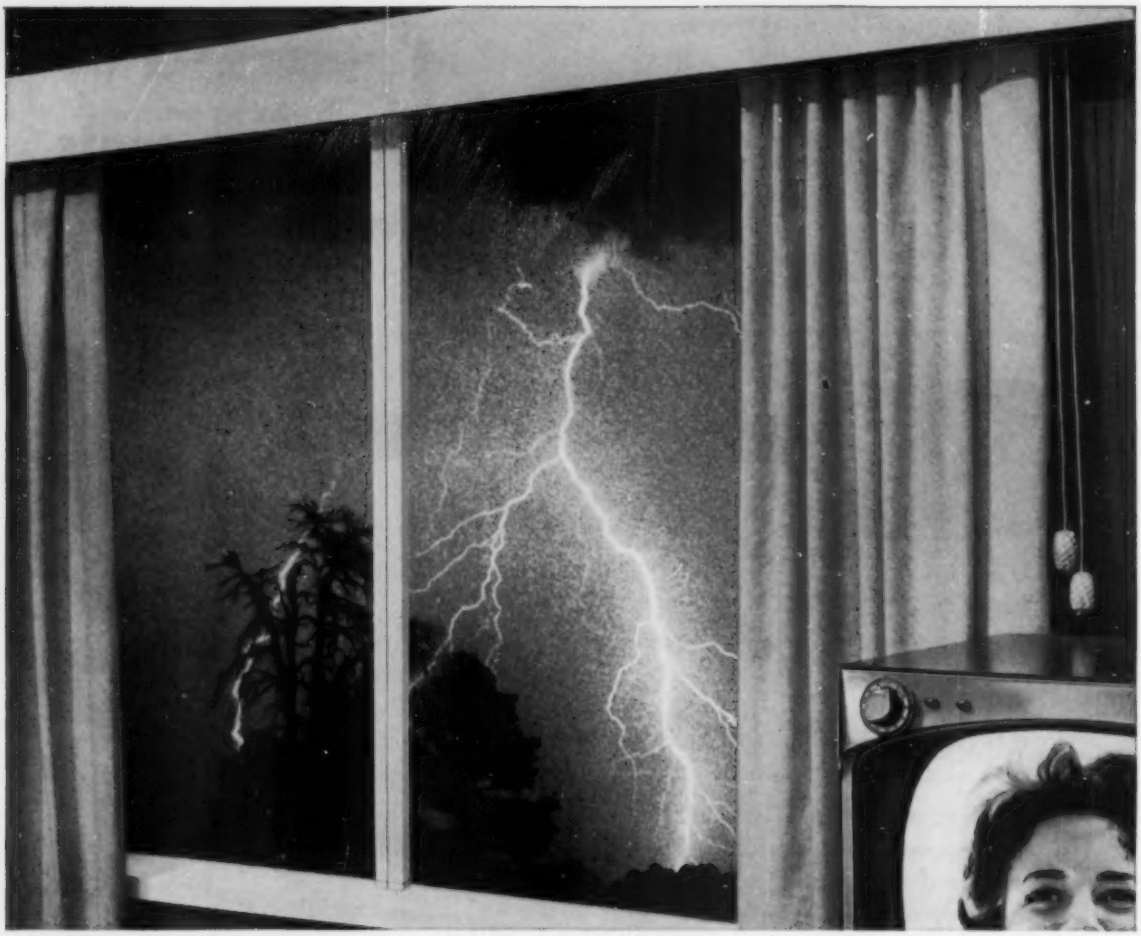
Write for your free copy of the Precision catalog on Dyna-seals



Precision Rubber Products Corporation • "O" Ring and Dyna-seal Specialists

3110 Oakridge Drive, Dayton 7, Ohio

Canadian Plant at: Ste. Thérèse de Blainville, Québec



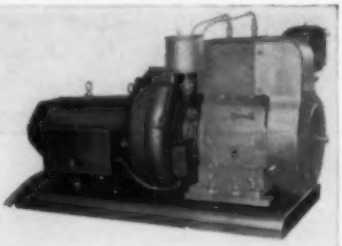
Leland generators guard the air waves

Keeping communication channels open despite failure of normal power is but one of the *many* jobs dependable Leland generators have been doing for years.

Take remotely located micro-wave relay stations that are often at the mercy of the elements. They must *unfailingly* "beam" the signal through . . . to brighten your home with TV. . . provide State Police communications . . . control many vital operations from commercial pipelines to national defense warning systems.

Rugged Leland generators, in special electric/gas-driven power units, regulate the normal power supply day in and year out . . . *take over completely and automatically* the instant normal power fails . . . provide uninterrupted service. With Leland generators in the system there's never a moment's delay.

A soundly engineered Leland unit is a safe bet to make *your* product better. Investigate Leland generators . . . and complete line of motors from ⅙ through 5 hp, soon to 20 hp, in all popular types and enclosures. Write today.



Developing 5 KW, a dependable Leland motor-alternator is a major component of this special "Micro-Power" unit designed for all communications services.

Another AMF Product

LELAND MOTORS

THE LELAND ELECTRIC COMPANY

Dayton 1, Ohio

Division of AMERICAN MACHINE & FOUNDRY COMPANY

if you make appliances

you should know about

SHARON SPECIAL STEELS

More and more of the nation's appliance manufacturers are turning to Sharon for such special steels as: *Sharonart*, the rolled-in design steel — *Stainless*, with the finest finish in the industry — Deep Drawing *Alloy* of consistent high quality and uniformity — *Galvanite**, an improved hot dip zinc coated steel.

In fact, when it comes to special steels to improve product design or quality, they look to come to Sharon, prime producers of special steels for the automotive, appliance and allied industries for more than 50 years.

SHARONSTEEL

Appliance Manufacturers
Should Have These Booklets:

430 STAINLESS — a complete review of a popular straight chromium grade.

GALVANITE* — The story of one of the most popular hot dip zinc coated steels.

SHARONART* — Rolled-in design steels with excellent illustrations.

*Trademark registered by Sharon Steel Corporation

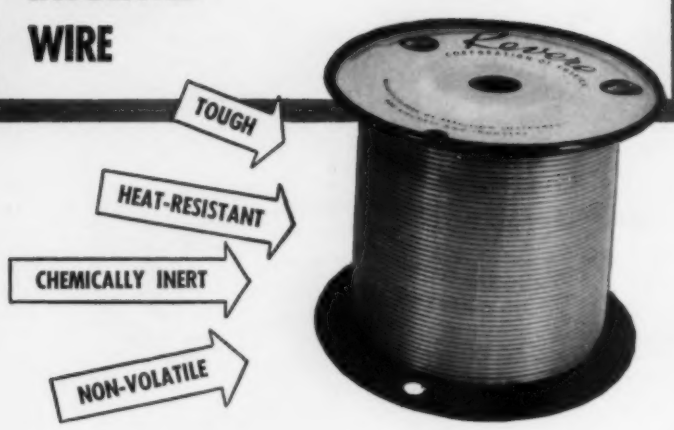
SHARON STEEL CORPORATION *Sharon, Pennsylvania*

District Sales Offices: Chicago, Cincinnati, Cleveland, Dayton, Detroit, Grand Rapids, Indianapolis, Los Angeles, Milwaukee, New York, Philadelphia, Rochester, San Francisco, Seattle, Sharon, Montreal, Que., Toronto, Ont.

REVERE

Revcothene*

INSULATED WIRE



Because of its extreme toughness, high heat resistance, and chemical inertness, Revcothene insulated wire is widely recommended for hermetically sealed equipment . . . for devices operating with small gauge wire at high temperatures . . . and for conditions where corrosion is a problem.

Revcothene is silver-plated copper wire with an extruded coating of monochlorotrifluoroethylene. Even at 150° C. (302° F.) the insulation is inert . . . with no volatile lacquers or plasticizers to ruin contacts. Revcothene withstands abrasion and flexing, and resists such corrosives as ozone, acids, alkalis and petroleum products.

Available in eight standard sizes from 28 to 10 gauge . . . in 15 colors. Flexible strandings, copper or silver braid shielding, heavy wall insulation and jacketing can also be furnished. Multiple-conductor cables are also available.

Revcothene is only one of many insulated wire and thermocouple wire products made to exacting specifications by Revere Corporation of America. Technical design assistance gladly offered. Write today.

TYPICAL SPECIFICATIONS — 22-Gauge Revcothene Wire

Spark Test Voltage	7500
Insulation Resistance	1000 megohms/1000'
Operating Temperatures:	
Flexing Application	—40° C. to 135° C.
Non-Flexing Application	—65° C. to 150° C.
Flammability	Does not support combustion
Operating Voltage	1000 volts
Water Absorption	0.00
Effect of Acids & Alkalis	Generally unaffected
Cold Flow (Compressive Strength)	32,000 PSI
Abrasion Resistance (MIL-T-5438)	Passes 36"-400 grit aluminum oxide with 0.3 pound weight

*Revere's tradename for monochlorotrifluoroethylene

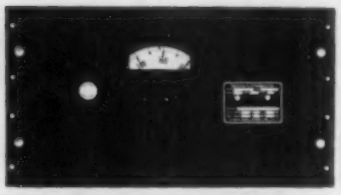
Revere CORPORATION OF AMERICA 2

WALLINGFORD, CONNECTICUT A subsidiary of Neptune Meter Company

employ rectified ac to furnish dc power to the drive motor. Constant torque is said to be supplied over the entire speed range. Desired speed can be pre-set from a remote location if desired.

Plug-in printed circuit boards are used in the half-wave equipment. The full-wave unit employs full-wave rectification circuitry designed to minimize torque pulsations. Full-wave drives are available in ratings of ¼, ⅓, ½, and ¾ hp. General Electric Co., Schenectady, N. Y.

For more information—
Circle 81, inside back cover



Potentiometer Transmits Pneumatic Signal

This instrument is equipped with a pneumatic transmitter which sends a 3-15 psi signal proportional to the measured variable. It is available in either potentiometer or bridge circuits, and will measure any variable which can be translated into an electrical quantity. It is possible to transmit measurements such as speed, viscosity, pH, resistance, smoke density, current and voltage, frequency and conductivity. Bristol Co., Waterbury 20, Conn.

For more information—
Circle 82, inside back cover

Analog-to-Digital Converter

The purpose of the converter is for accurate long-distance transmission of data representing voltage, current and power. This unit is a photo scanner which converts an analog meter indication into digital form for serial or parallel long-distance transmission. The converter uses a conventional pointer-type meter without modification of the movement or loading of the output shaft.

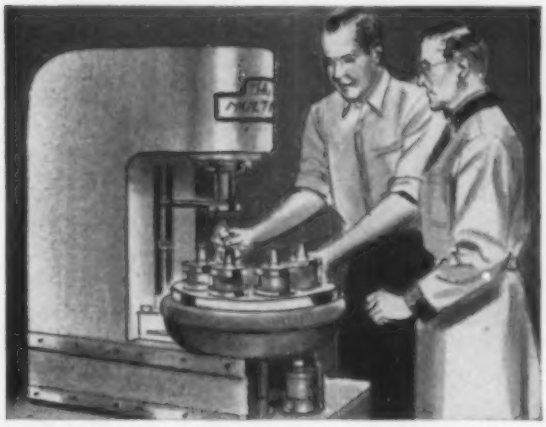
The basic elements of the meter-

(Continued on page 316)

Complete hydraulic service... from one dependable source...

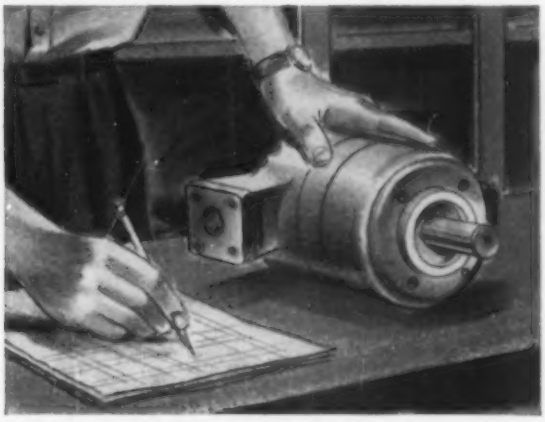
DENISON

FREE APPLICATION ENGINEERING by experienced hydraulics specialists to improve your circuits.



JOB DEMONSTRATIONS to *prove* how your operations can be made more efficient with the new hydraulic developments.

REGIONAL FACTORY SERVICE includes *complete maintenance facilities* for building, testing, repairing equipment.



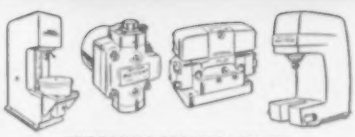
OVER-THE-COUNTER SALES from local stock to give you *immediate delivery* of hydraulic pumps, motors and controls.

Behind the name Denison... With its regional warehouses and branch offices, Denison's factory service is now as near as your telephone. Specialists in hydraulics are immediately available to help you build a better product, build it for lower cost.

Regional Warehouses in Chicago, Houston, Los Angeles, Clark, New Jersey. Branches in every principal city.

THE DENISON ENGINEERING COMPANY
1194 Dublin Road • Columbus 16, Ohio
A Subsidiary of American Brake Shoe Co.

DENISON HydrOILics



HYDRAULIC PRESSES • PUMPS
MOTORS • CONTROLS

Announcement!

...Cleveland

now offers a complete line of

Top Quality

Socket Screws

Our line of socket screws has been expanded to include all standard socket items, in all catalog sizes, made to Cleveland's extra high standards of quality.

- Socket Head Cap Screws
- Socket Set Screws
- Flat Head Socket Cap Screws
- Button Head Socket Cap Screws
- Shoulder Screws
- N.P.T.F. Pressure Plugs
- Socket Screw Keys
- Precision Dowel Pins

Complete stocks of Cleveland Socket Screw Products are available for immediate shipment. Write for new Socket Line Folder.

Among the facilities already in use at the modern new Cleveland plant is this spacious metallurgical and chemical laboratory.

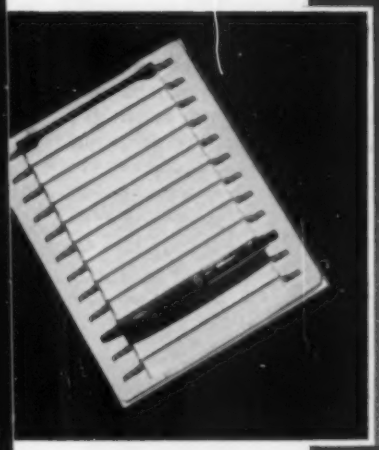
The Cleveland Cap Screw Company

2936 East 79th Street • Cleveland 4, Ohio • VUlcan 3-3700 TWX CV-42

Warehouses:

Chicago • Philadelphia • New York • Providence • Los Angeles

TRY A Parker Jotter NOW!
Out-performs and out-lasts any other Ball Point Pen! $2.95
Exclusive Jotter refill out-lasts 5 ordinary refills!



A sheet of BAKELITE Brand Impact Styrene, formed to fit 12 PARKER Jotters, holds these ball-point pens firmly in the package and on display. It was formed by **Janesville Paper Box Co.**, Janesville, Wis., from sheets extruded by Midwest Plastic Products, Chicago, Ill.

Vacuum-formed impact styrene sheets provide

"write your own ticket" latitude

This tray has grooves vacuum-formed to such a precise fit that they hold each pen firmly in place. It keeps the pens safe in shipment. And for display, the tray is quickly slipped into the display case. The pens stay neatly in order. The sheet of BAKELITE Brand Impact Styrene—white, smooth, and easy to clean—sets off the colored pen barrels.

The variety of products vacuum-formed from extruded sheets of BAKELITE Brand Impact Styrene ranges from the small trays illustrated to large refrigerator door liners. They all possess the same advantages—toughness, excellent appearance, accurately formed details.

Vacuum-forming is growing fast because of its speed and economy. BAKELITE Impact Styrene is ideally suited to this process because it can be extruded into sheets that keep their gloss and toughness after forming. The products that result have excellent impact resistance plus good finish. Their color range is practically unlimited.

You can investigate the possibilities of vacuum-forming BAKELITE Impact Styrene for your own product with the aid of qualified Bakelite Company technical representatives. Write Dept. SU-145.

BAKELITE BRAND PLASTICS

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.

In Canada: Bakelite Company, Division of Union Carbide Canada Limited, Belleville, Ontario

The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC

Comfort...
NEEDS LUBRICATION, TOO!

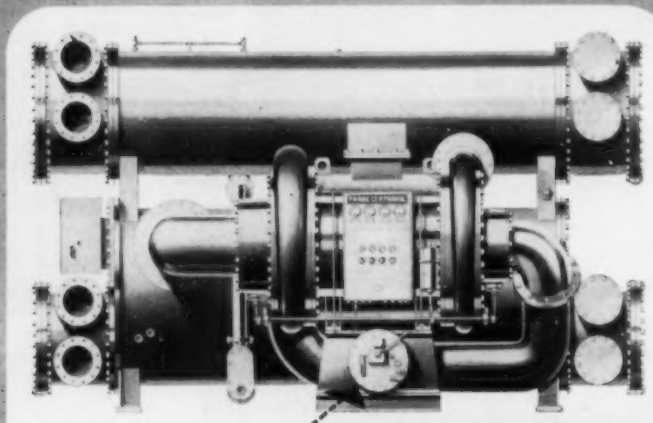
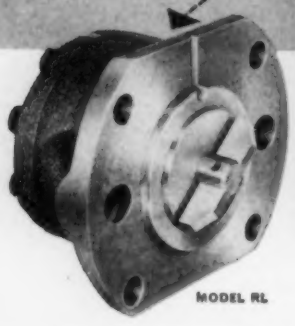


Photo of CenTraVac, courtesy The Trane Company, LaCrosse, Wisconsin



MODEL RL

How TUTHILL PUMPS Help the Trane "CenTraVac" Keep Customers Cool

In developing the unique CenTraVac hermetic centrifugal refrigeration unit, Trane engineers required a positive lubrication system that would be both simple and foolproof. For the heart of this system, they selected the Tuthill Model RL—a positive displacement, internal-gear rotary pump with automatic reversing feature.

The performance characteristics of this pumping unit make it most dependable for pressure lubrication service. Model RL holds its prime and delivers the capacity needed instantly—a "must" in the CenTraVac, since full oil pressure must be developed before the unit will start—let alone operate.

Quiet in operation—also a "must" in CenTraVac—Model RL is built for long, uninterrupted service. Its automatic reversing feature offers further insurance of positive lubrication, since the pump will deliver from the same port regardless of ultimate direction of shaft rotation.

Whether you need standard or special pumps for lubrication, coolant, hydraulic, or liquid transfer service, you are invited to submit your specifications for recommendations.

Write for catalog data on Tuthill pumps for your specific needs.

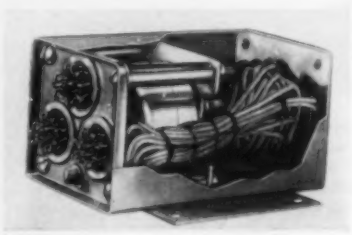
See our catalog in Sweet's Product Design File—6b-Tu

TUTHILL PUMP COMPANY
Dependable Rotary Pumps . . . since 1927
939 East 95th Street, Chicago 19, Illinois

Canadian Affiliate: Ingersoll Machine & Tool Co., Ltd., Ingersoll, Ontario, Canada

reader are: 1) a photocell and light source assembly; 2) a pointer path length mirror; 3) a small motor; 4) a code disc; 5) a sensitive relay; and 6) a group of digit storage relays, one for each digit of the code disc. Bendix Aviation Corp., 11600 Sherman Way, N. Hollywood, Calif.

For more information—
Circle 83, inside back cover



Sealed Switches, Relays

Hermetically sealed rotary selector switches and stepping relays are applicable in the aircraft, automation and electronics fields. They are protected from the effects of salt spray, fungus and humidity.

These units are hermetically sealed in an inert atmosphere of dry nitrogen, with a slight trace of helium. G. H. Leland, Inc., 123 Webster St., Dayton, Ohio.

For more information—
Circle 84, inside back cover

Automatic Control System

This device consists of a motor incorporated in a system which permits a multiple series of operations to be programmed on tape or punched cards for the completely automatic operation of milling machines, lathes, grinders, drills and other machine tools. The drive is basically a step motor.

Standard sizes will cover outputs ranging from inch-ounces of torque to thousands of inch pounds. Because several motors can be coordinated on

(Continued on page 319)

in the home everybody benefits from

STAINLESS STEEL

THE ARCHITECT designs Stainless Steel into windows, kitchens, work surfaces, ovens and other important places because he knows there is nothing like Stainless for clean, lasting beauty.

THE BUILDER has had long experience with Stainless Steel. It's easy to install, does not chip or peel, and its beautiful finish presents no problem on matching or replacement.

the owner likes living with Stainless Steel. It's always gleaming and beautiful, cleans with a wipe, and lasts forever. And, to complement her kitchen she loves to own those shiny pots, pans, tableware, and appliances, all made of Stainless Steel.

McLOUTH STAINLESS STEEL

FOR THE PRODUCT YOU MAKE TODAY AND THE PRODUCT YOU PLAN FOR TOMORROW SPECIFY McLOUTH HIGH QUALITY SHEET AND STRIP STAINLESS STEEL

McLOUTH STEEL CORPORATION DETROIT, MICHIGAN • MANUFACTURERS OF STAINLESS AND CARBON STEELS

Flash-Butt Welding

How to Use It to Improve Product Design and Quality

What is Flash-butt Welding?

Flash-butt welding is a resistance welding process for end to end joining of rods, tubes, bars, forgings, fittings, etc., to achieve the greatest possible strength. It is accomplished by positioning the pieces to be joined with clamping electrodes so that there is initially light contact between abutting edges (Fig. 1).

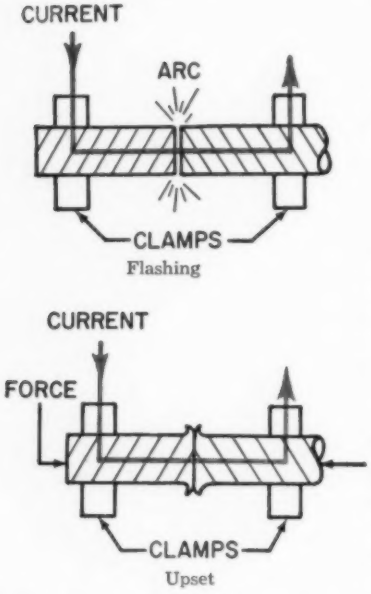


Fig. 1. Flash-butt welding process.

Introduction of the current causes flashing which generates great heat. As the metal is burned away the pieces are moved together in an accelerating motion. Thus, uniform flashing action is maintained for the most efficient heating process. When the inner faces obtain the proper temperature, they are forced together under high pressure and the current is cut off. The impurities (oxides, slag, etc.) formed during flashing are forced out in the upset action leaving pure base metal to form a high strength bond (Fig. 3).

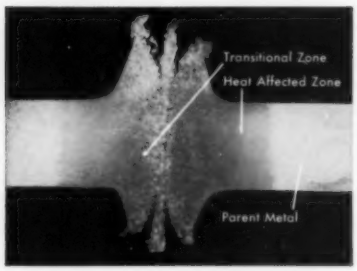


Fig. 2. Macrograph of 2" O.D. x .095" wall of 4140 alloy steel tubing flash-butt welded on a Sciaky Type BMW. 3-400 machine.

Advantages of Flash-butt Welding

Flash-butt welding offers a 100% strength factor compared to 80% strength factor for flame and arc welds. Further, no extra material such as gas, rod, or flux is required. *The material itself forms the weld.*

Flash-butt welding has low power demand and power consumption. Higher production speeds are more readily achieved with this process than with any other fastening method. The localized heat minimizes part distortion. Generally, no special preparation of the weld surfaces is required.

Simplicity and effectiveness of the Sciaky Flash-butt weld technique reduces multi-step fastening operations to just one. One operator (not skilled) can consistently produce high quality welds.

Dissimilar metals with widely varying melting temperatures are easily flash-butt welded.

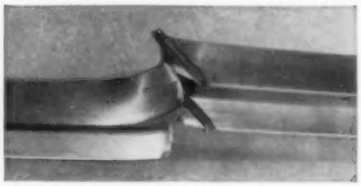


Fig. 3. Destruction test on extruded aluminum miter joint. Note that failure is in parent metal, not in the weld.

When to Design for Flash-butt Welding

Whenever ideal flash-butt welds are required, the size and shape of the parts to be welded should be identical. However, a maximum of 15% variation in end dimension is usually permissible for commercial usage. New applications for this process are opening up every day. Often little, or no change in existing design allows conversion to high production flash-butt welding.

New Research Center for Your Design Problems

Sciaky's new three-quarter million dollar Research Center is equipped with the most advanced resistance welding machines, testing instruments, and trained personnel. The entire facility is devoted to solving *your* joining problems and advancing the application and development of resistance welding. The Research Center invites *you* to submit your fastening design problems.

Build Your Data File with Free Sciaky Literature

Write today on your company letterhead describing your particular field of interest. We will send suitable back issues (as well as future issues) of our "Resistance Welding At Work" publication, showing typical design problems solved by this method of fastening. All contain impressive case history examples of Sciaky basic thinking—resistance welding techniques designed to do more *useful work* at *lower operating costs* with *maximum reliability.*

Largest Manufacturers of Resistance Welding Machines in the World

SCIAKY®

Sciaky Bros., Inc., 4913 West 67th Street, Chicago 38, Ill., Portsmouth 7-5600

a single tape, three or more units can be tandemed for the multiple operations required by machine tools. Teller Co., Butler, Pa.

For more information—
Circle 85, inside back cover

Traction Type Fluid Drive

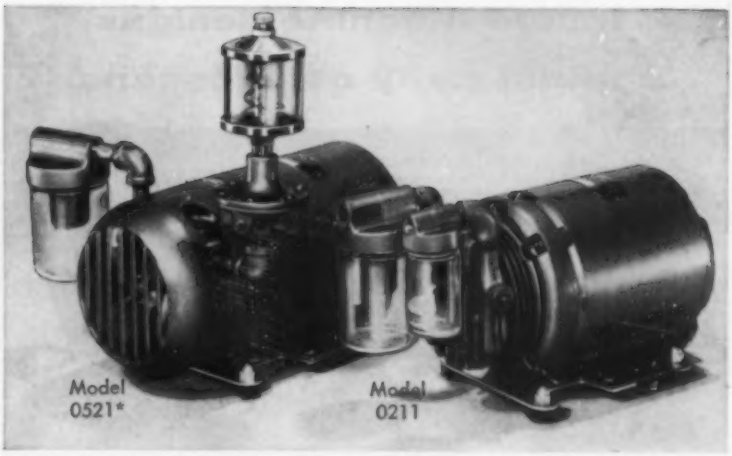
The basic unit is designed for use with internal combustion engines, as a fluid power transmission for mobile material handling vehicles and construction equipment. Power rating in these applications is 25 to 85 hp, depending upon drive speed. As a motor-driven unit, the fluid drive is rated 7½ to 15 hp for 1200 rpm drive speed, and at 25 to 50 hp for 1800 rpm. Dimensions for the basic unit are 7⅛ x 14⅛ in. OD. American Blower Corp., Detroit 32, Mich.

For more information—
Circle 86, inside back cover

Subminiature Relay

The relay is available from stock with a 2000-ohm coil, and in sample quantities with 1000, 500, 200, and

(Continued on page 320)



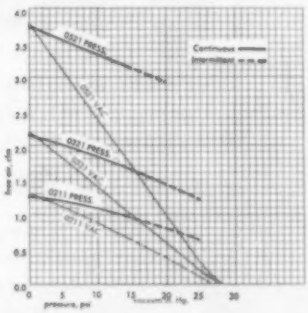
Get 10 Integral-Motor-Pump advantages in two NEW types (three models) of

GAST rotary vane AIR PUMPS

Designers seeking a dependable vacuum or pressure source for industrial instruments, vending machines, air gauge circuits, air sampling, laboratory equipment, printing and packaging machinery, etc., will find these *new* Gast Integral-Motor Air Pumps highly advantageous, especially where compactness and portability count. Consider these outstanding features:

1. Latest type G.E. "Form G" motors.
2. More compact than any pump of equal capacity.
3. Total weight reduced ⅓—cuts shipping costs.
4. Motor mounting time and labor eliminated.
5. Simple, trouble-free rotary-vane design.
6. Vanes take up their own wear automatically.
7. Positive displacement, pulseless air delivery.
8. Improved appearance—smoother exterior.
9. Dependable for original equipment; plant use.
10. Forced air fan cooling on Models 0321 & 0521.

Performance-Vacuum & Pressure



Write for new Bulletins V-356 and P-356!
GAST MANUFACTURING CORP.,
P. O. Box 117-V Benton Harbor, Mich.

*0321 similar in appearance.

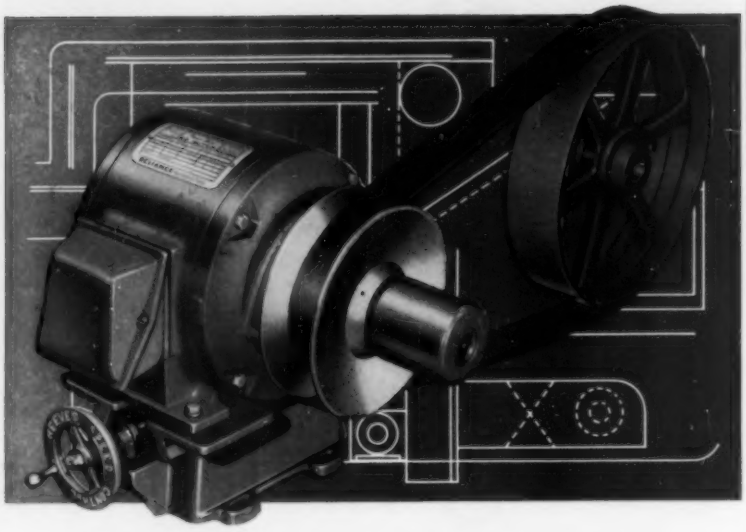
Original Equipment Manufacturers for Over 25 Years

GAST ROTARY

- AIR MOTORS TO 4 H.P.
- COMPRESSORS TO 30 P.S.I.
- VACUUM PUMPS TO 28 IN.

SEE OUR CATALOG IN SWEET'S PRODUCT DESIGN FILE

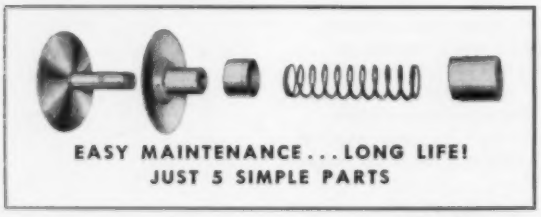
Insure machine designs against early obsolescence



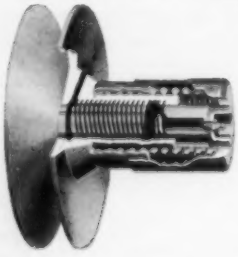
REEVES

Vari-Speed Motor Pulley

A compact, low-cost variable speed drive that widens machine range . . . adds flexibility. Fourteen models for ⅛ to 15 hp; 1.75:1 to 4:1 speed ratio.



REEVES "Close-grooving" —a special lubrication system—insures free sliding disc for easy speed changes.



For bulletin complete with rating charts and dimensions, write Dept. K21a-V545.

REEVES DIVISION • COLUMBUS, INDIANA

RELIANCE ELECTRIC AND ENGINEERING CO.

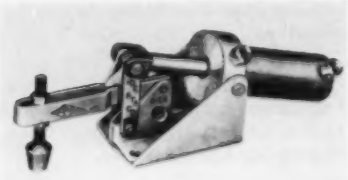
50-ohm coils with 100-mw sensitivity. Weighing ⅛ oz, the relay measures ¼ x ½ in. Elgin National Watch Co., Elgin, Ill.

For more information—
Circle 87, inside back cover

Sequencing Air Valves

These valves provide for a pre-set pattern of operations to be automatically carried out by a machine after the operator initiates the cycle. Cylinders can be sequenced by position or time, and their action interlocked in the circuit. Available models include straightway, three-way, normally opened and normally closed, four-way. They are provided for base mounting or inline mounting, in sizes ¼ to 1¼ in. Ross Operating Valve Co., 134 E. Golden Gate Ave., Detroit 3, Mich

For more information—
Circle 88, inside back cover

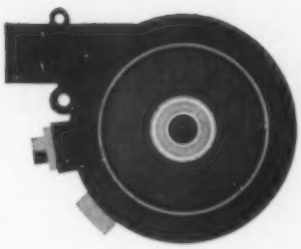


Air-Operated Toggle Clamp

Measuring 12 x 5⅜ x 3¼ in. wide, this clamp is available in two styles, with U-bar for vertical and lateral adjustment of pressure spindle, and with solid bar and bolt retainer. Several types of adjustment spindles are avail-

(Continued on page 325)

DO YOU USE FABRICATED METAL PARTS? .. VOLUME GOING UP?



.. this chart shows how Richardson molded parts can reduce production costs (example: a water pump housing):

Year	Production Method	Total Annual Quantity	Total Cost	Unit Cost
1st year	fabricated metal	3,600 pump housings	labor and material $7,200.00	$2.00
2nd year	molded plastics	now increased to 12,000 pump housings	plastic mold ..... $8,000.00 12,000 housings purchased from Richardson 9,000.00 $17,000.00	$1.42
3rd year	molded plastics	same quantity—12,000 pump housings	mold (charged off on previous year's production—still good for hundreds-of-thousands of parts) ..... — 12,000 housings purchased from Richardson $9,000.00 $9,000.00	only 75c

Molded parts also offer these advantages:

.. smooth, attractive surface!

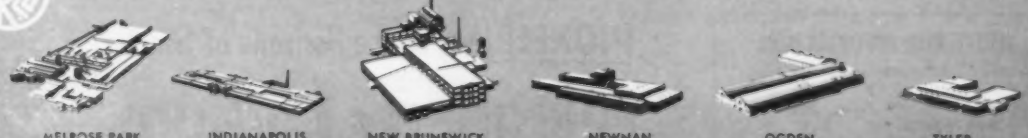
.. no painting necessary—plastic is rustproof!

.. save assembly time—inserts mold in!

.. plastic reduces noise and insulates against heat!

Richardson engineers are available to assist you in determining molding costs. Working with your own engineers, they can cooperate in the development of new designs for improved performance, better appearance, and reduced production costs .. experienced tool and diemakers, working in one of industry's largest tool and die shops, can produce long-lasting molds accurately. Write or phone today—Chicago, MAnsfield 6-8900. The Richardson Company, 2793 Lake St., Melrose Park, Illinois (Chicago area).

RICHARDSON PLASTICS MOLDED AND LAMINATED



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For your selection

ALTEMP

HIGH TEMPERATURE SUPER ALLOY STEELS

ALTEMP A-286 . . . an austenitic iron-nickel-chromium alloy made heat-treatable by the addition of titanium. Designed to maintain high strength and corrosion-resistance up to the 1350 F range, and to afford satisfactory scale resistance up to 1800 F.

A-286 was developed in the A-L Research Laboratory in Watervliet, N.Y., in the 1949-51 period. Among the high-strength, heat-resisting alloys, it has exceptionally low strategic alloy content, improved hot-working and machining qualities, and good center ductility in large sections. Currently used in jet engines and superchargers for such applications as turbine wheels and blades, frames, casings, afterburner parts, bolting, etc.

This alloy is readily produced in large quantities without the need of special steel-making equipment. It is available in the form of billets, bars, forgings, sheet, strip, tubing and hot-extruded shapes.

ALTEMP S-816 . . . a chromium-nickel-cobalt base alloy, strengthened by additions of molybdenum and tungsten, and with a columbium-carbon ratio of ten to one to insure its structural stability. Designed for high strength and corrosion-resistance service in the 1200-1500 F range, and at higher temperatures under lower stress conditions. Developed in the A-L Research Laboratory at Watervliet, N.Y. in the years of 1940-43, and engine-tested and proved for periods of over 30,000 hours.

S-816 is used currently for turbine blades in two of the production jet engines, also in a number of experimental aircraft and commercial gas turbines. Except for seamless drawn tubing, it is available in practically all forms and shapes in which stainless steels are processed, including hot extrusions.

ALTEMP S-590 was designed for service in the range of 1100-1400 F temperatures where high strength and corrosion resistance are required, and where cost is also a factor. Unlike S-816, which is practically a non-ferrous alloy, S-590 has a chromium-nickel-cobalt-iron base. However, it employs the same molybdenum and tungsten additives, and the same columbium-carbon ratio.

S-590 was developed at the Watervliet Laboratory and field-proved during the same years as S-816. It is available in the same shapes and forms, and is currently being used for turbine blades and wheels in experimental commercial gas turbines.

OTHER GRADES . . . among the many other Super Alloys made by Allegheny Ludlum are V-36, M-252, 19-9 DL, 19-9 DX and Waspaloy.

Do you have a high temperature problem? The services and experience of our Research Laboratories and Technical Staff are completely at your command. *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.*

WSW 9310 R

WRITE FOR INFORMATION

Certified laboratory data on the properties of Allegheny Ludlum high temperature Super Alloy Steels are yours on request.

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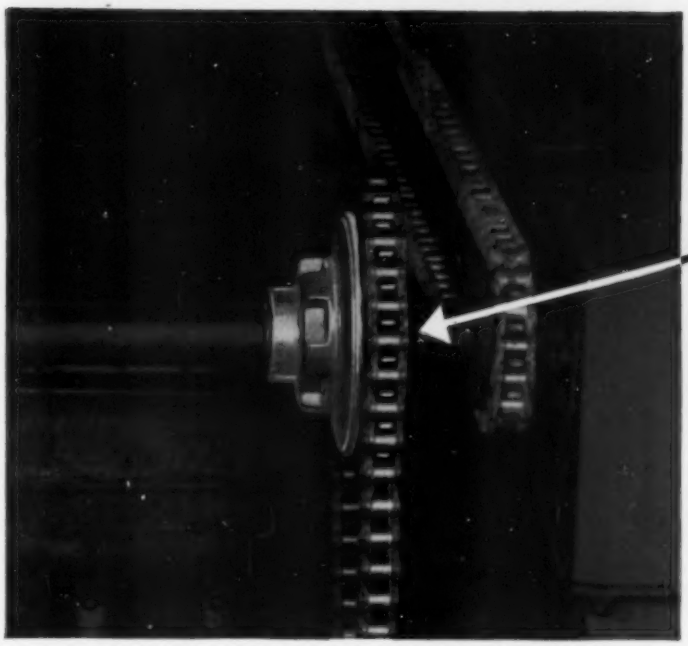
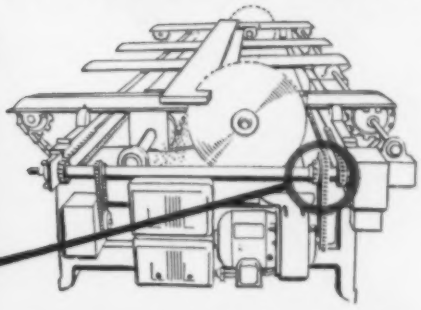
Stocks of AL Stainless Steels carried by all Ryerson warehouses

AL® LEADING PRODUCER HIGH-ALLOY STEELS

MORSE TORQUE LIMITER PROTECTS MOTOR AND REDUCER FROM DEAD-STOP OF DRIVEN UNIT!





Morse Torque Limiter and sprocket act as slip clutch on Model 55 Automatic Electric Shift Trimmer made by The Wheland Company, Chattanooga. Arbors are shifted at 120 fpm, instantly stopped and locked into place. Torque Limiter on jackshaft is set so sprocket slips when motor torque (38 ft.-lbs.) is exceeded. Absorbs inertia of 1-hp, 155-rpm gearmotor; reduces shock on drive unit when driven shaft is stopped.

Typical application shows how you can safeguard drive units and eliminate shear pins

Check these advantages of Morse Torque Limiters

- √ Eliminate downtime
- √ Torque-sensitive and fully adjustable
- √ Completely automatic and dependable
- √ Resume operation automatically
- √ Compact, standard sizes

In this Wheland Electric Shift Trimmer, two 200-pound saw arbors are automatically moved into position at 120 feet per minute . . . then stopped dead and locked into place.

The tremendous shock transmitted to the drive mechanism when the arbors are stopped, is safely dissipated by a Morse Torque Limiter used as a slip clutch between the driving and driven units. In addition, it prevents motor inertia from building up torque in the drive.

Versatile Morse Torque Limiters can safely control many of the shock-load problems present in your machine operations.

These simple devices are dependably sensitive and easily adjusted to desired torque limits. When overload or jam-up is cleared, they automatically resume operation, eliminating downtime or dismantling necessary with shear pins.

Send for Free Catalog

A full line of Torque Limiters is stocked by your Morse Distributor. For free catalog, or power transmission engineering help, see him or write today.

MORSE CHAIN COMPANY • INDUSTRIAL SALES DIVISION • ITHACA, N.Y.

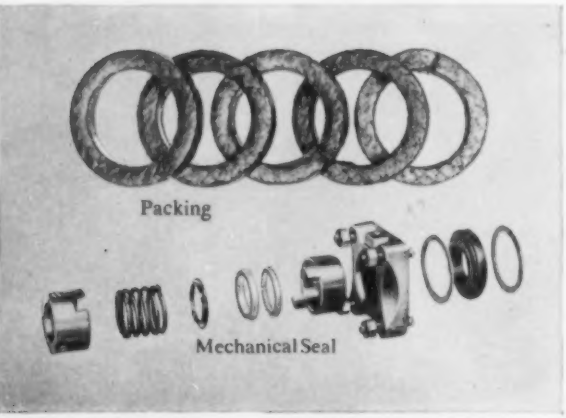
MORSE

MORSE B-W *trademark

POWER TRANSMISSION PRODUCTS

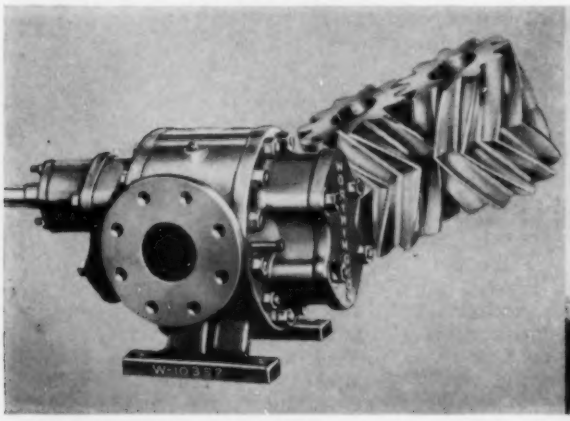
WHAT'S YOUR P.Q.?*

*PUMP QUOTIENT



Pump standardization—how do you benefit? By standardizing, you can often drastically cut your spare parts inventory. With Worthington's SESC (Standard End Suction Centrifugal) line, you are also assured of immediate delivery from factory or distributor stocks. Because the SESC line consists of standardized "parts" not "pumps," it can be built in many different combinations . . . 70,480 to be exact. For all these reasons, more and more companies are turning to SESC pumps. See bulletin W-300-B4.

Packed stuffing box or mechanical seal—which is preferred? Each has its applications. Mechanical seals are gaining in popularity year after year. With Worthington's Standard End Suction Centrifugal pumps you not only get your choice of mechanical seals—or packing—but you can easily convert from one to the other using standard stock parts. This "interchangeability" is just one of the many extra advantages of Worthington's SESC line. For more details write for bulletins W-300-B4 and W-350-B16.



Which pump is best for difficult suction conditions? Worthington's close-clearance rotary pump is self-priming and can operate under vacuums as high as 28 inches of mercury. The large unobstructed suction opening in this herringbone gear pump permits operation with thin or viscous liquids at high efficiency. The double-helical gears balance all end thrust, eliminate trapping of liquid between gear teeth and provide a quiet, pulsation-free flow at high speeds. For the full story, ask for bulletin W-483-B2.

Whose pumps would you expect to find in the Eiffel Tower? If you said "Worthington's," your P.Q. is all right. The original steam-driven pumps that power the Eiffel Tower's 100-passenger hydraulic elevators were built by Worthington back in 1889. The most recent additions, modern electric-drive Worthington pumps, moved into the Tower just last year. Today as then, wherever men must move liquid, they turn to the company with a reputation for performance. Worthington Corp., Harrison, N. J. PC. 6.5

WORTHINGTON

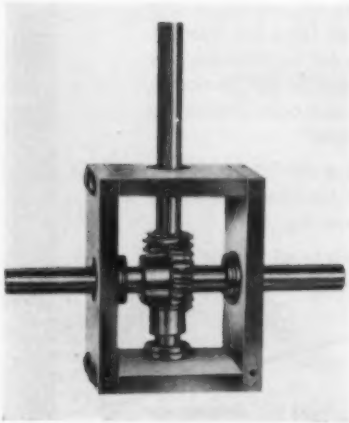
able. Air cylinder bore is 1½ in. with a stroke of 2¼ in. and is fitted with two cylinder restrictor fittings. Detroit Stamping Co., 346 Midland Ave., Detroit 3, Mich.

For more information—
Circle 89, inside back cover

Self-Aligning Spherical Bearings

These spherical bearings are said to reduce lost motion in linkages and withstand excessive vibration. They are available in sizes for ⅜ bore to 1⅞ in. bore, with radial ultimate static load capacities from 3000 to 152,700 lb. Southwest Products Co., 1705 S. Mountain Ave., Duarte, Calif.

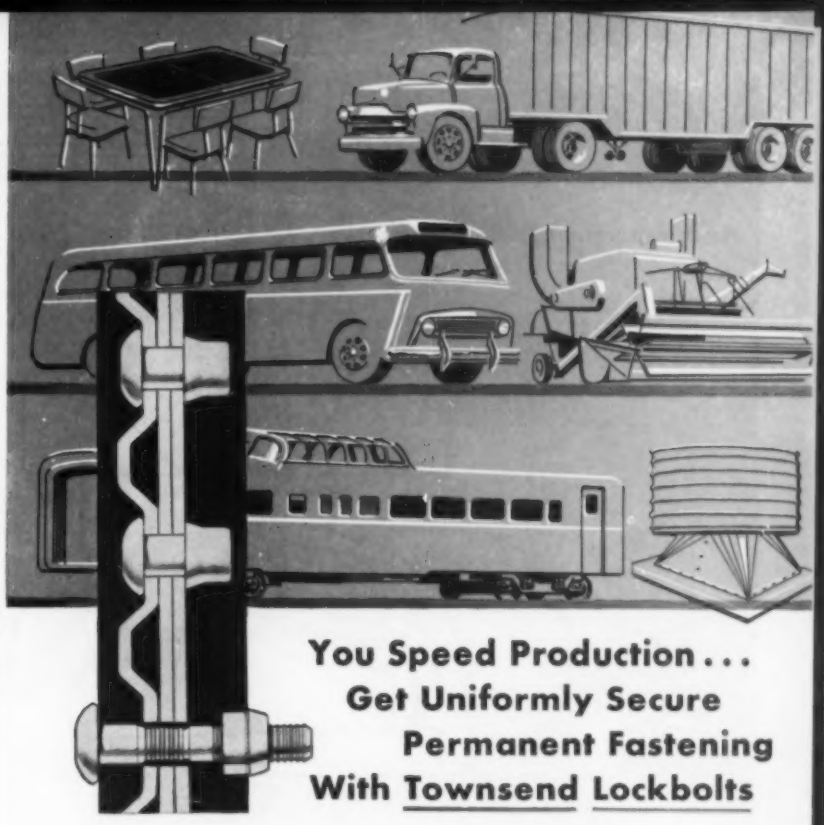
For more information—
Circle 90, inside back cover



Right-Angle Gear Reducers

Right-angle drives for control shafts have dual output shafts. Two basic types are available with a variety of input-output ratios, a bevel gear as-

(Continued on page 328)



**You Speed Production . . .
Get Uniformly Secure
Permanent Fastening
With Townsend Lockbolts**

The Townsend lockbolt provides a quick method of producing uniformly secure fastenings that cannot loosen even under extreme vibration or shock conditions. They combine the advantages of riveting and bolting—eliminate the disadvantages.

Typical users are manufacturers of railroad cars, highway trucks and trailers, buses, farm equipment, industrial ventilators, and furniture. They find that the use of Townsend lockbolts gives them an opportunity to improve their products—reduce unit costs.

These benefits are possible for several reasons. By use of Townsend lockbolts, fewer and less skilled workers can complete an assembly faster than by other methods because the setting action does not depend upon the skill of the operator. The clamping action, or tensile preload is higher than rivets—is more uniform than bolts and nuts. The lockbolt makes possible a more rigid joint because it fills the hole better than other fasteners.

Townsend lockbolts are available in steel and aluminum alloy, in 3/16", 1/4", 5/16", 3/8" and 1/2" diameters, in grip lengths ranging up to 2" in various head styles. Other material and lengths available upon request. They are described in Sweet's design file and in Townsend bulletin TL-101.

For a demonstration at your desk of how to get better, economical fastening with Townsend lockbolts, write on your company letterhead to Townsend Company, P. O. Box 237-D, New Brighton, Pa.

Licensed under Huck patent nos. RE 22,792, 2,114,493, 2,527,307, 2,531,048, 2,531,049.

Townsend
COMPANY • ESTABLISHED 1816
NEW BRIGHTON, PENNSYLVANIA
Sales Offices in Principal Cities
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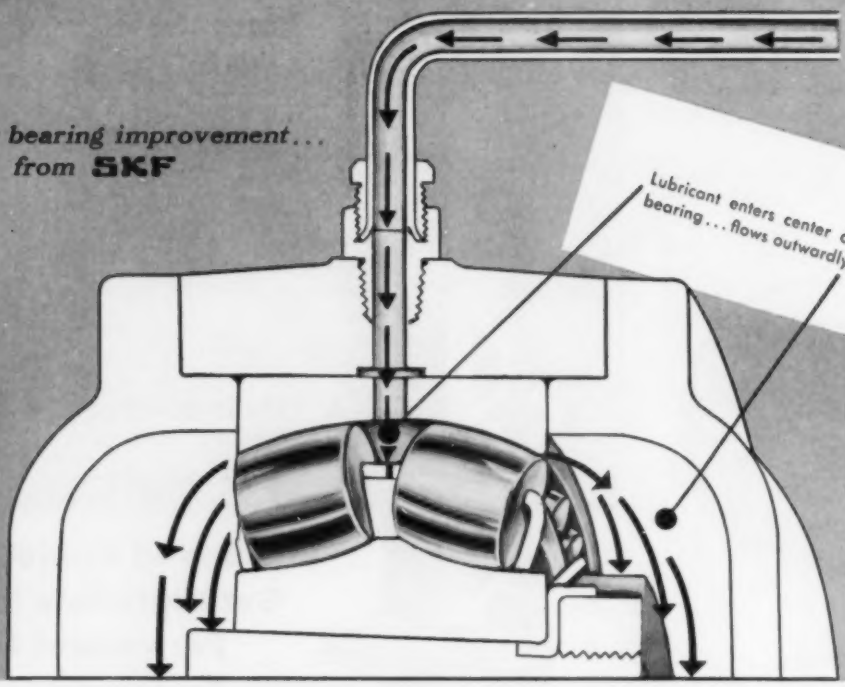
Another bearing improvement... from **SKF**



NOW AT NO EXTRA CHARGE-

SKF's improved method of lubricating large spherical roller bearings

To make the lubricant effective it should be located where needed—in the bearing. Also, new lubricant, when added, should enter where it does the most good—in the bearing.

For these reasons, all future production of SKF double row spherical roller bearings above 240 mm O.D. (9.4488") will be made with three equally spaced drilled holes in the center of the outer ring without any extra charge to our customers. *This permits the lubricant to enter the center of the bearing.*

With the lubricant (either grease or oil) being introduced into the center of the bearing, all working surfaces are quickly and completely covered. In addition, the outward flow flushes out the old lubricant, and with it, any abrasive dust, dirt, moisture or other impurities.

And where circulating oil lubrication is required, there is a continuous flushing and cooling of the bearing.

This is another example of how SKF helps you to obtain longer bearing life.

7711

Consult your SKF District Office today for complete information so that you can be the first to incorporate into your products this improved method of lubricating large spherical roller bearings.

SKF®

BALL AND ROLLER BEARINGS

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.

—manufacturers of SKF *and* HESS-BRIGHT® *bearings.*

A 2,370 lb.

CORED FERROUS FORGING

Large angular voids make this heavy component difficult to produce by any other method than Cameron's split die forging process.

The tremendous saving of machining time plus better grain structure on this launching valve body produce a superior component for our nation's defense.

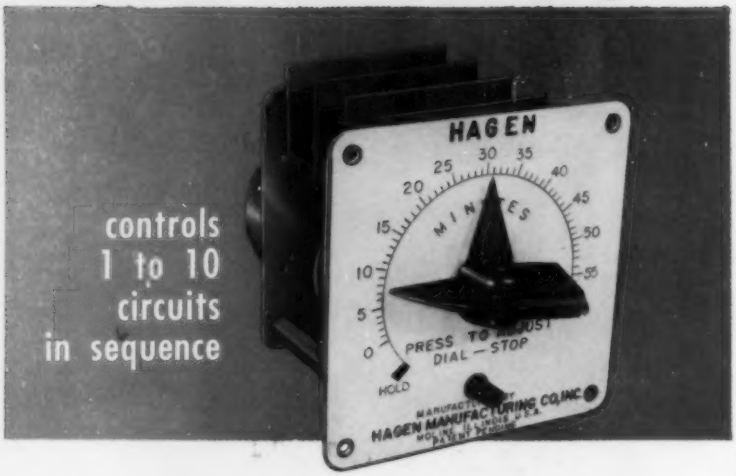
For large, intricate ferrous forgings with both internal and external contours in sizes from 200 to 5,000 pounds, write or call . . .

Cameron

IRON WORKS, Inc.

SPECIAL PRODUCTS DEPARTMENT
P. O. Box 1212, Houston, Texas

NEW HAGEN
hand set
time delay relay



Foolproof on Repeat Settings

No danger of over-timing when you repeat a process several times — each with the same timing. On the first run, operator simply presses the stop release button and sets the adjustable stop (both shown in blue) at the desired time . . . then turns the pointer as far to the right as it will go . . . it can't go beyond the stop. Thus the setting is always correct — on the first and all subsequent runs.

A synchronous motor returns the cam shaft to "O" position, tripping switches in accordance with time settings. The process is stopped automatically.

A wide selection of snap-action switches is available . . . as well as cam combinations. The Hagen Hand Set Time Delay Relay Model 73 is the answer to controlling solenoid valves in an industrial process, starting a group of motors in sequence, for pump controls, and many other uses.

Send for Bulletin 580

MAIL COUPON TODAY!

HAGEN
MANUFACTURING COMPANY INC.
Moline, Illinois
Subsidiary of Eagle Signal Corporation

HAGEN MANUFACTURING COMPANY, INC.
Dept. PE-856. Moline, Illinois

Please send Bulletin 580 on the new Hagen Hand Set Time Delay Relay.

NAME AND TITLE

COMPANY

ADDRESS

CITY ZONE STATE

sembly and a worm gear assembly. Both are assembled in anodized aluminum, dustproof housings, measuring 1 x 1½ x 1½ in., with gears permanently pinned to stainless steel shafts mounted in bronze bearings with constant pressure thrust washers.

One type is available with input-output ratios of 1:1, 2:1 and 3:1. The other series is available with the following input-output ratios: 5:1, 10:1 and 20:1. Jan Hardware Mfg. Co., Inc., 75 N. 11 St., Brooklyn 11, N. Y.

For more information—
Circle 91, inside back cover

Rotary Switch

This switch is 1¾ x 1¹³⁄₁₆ in. deep. It is available with three poles on a single deck and may be ordered with as many as nine positions per pole with shorting type action, or five positions per pole with non-shorting type action. Solid silver alloy contacts, rotors and slip rings are used.

The switch can carry up to 15 amp and break 1 amp non-inductive. It is also available in multi-deck construction. Daven Co., 580 W. Mt. Pleasant Ave., Livingston, N. J.

For more information—
Circle 92, inside back cover

Small Electric Clutches and Brakes

Miniature and small electric clutches and brakes in five styles and six sizes. The only moving part in actuation of this unit is a diaphragm. When current is applied to the magnet, the diaphragm yields as the armature is attracted to the magnet body.

Included among the five standard units are the clutch coupling, electric

(Continued on page 332)

AN (STANDARD)

For Aircraft, Electronic Instruments, Military, Industrial, and Commercial Applications

Standard AN-A, AN-B, AN-C . . . meet Specification MIL-C-5015B. **Plastic inserts.** 15 diameters, 260 insert layouts, 6 shell styles. AN3100 to AN3108 with all accessories. Interchangeability an outstanding feature. Many type assemblies directly available through distributors.

connect with CANNON PLUGS

AN-E (INT. AN-M)

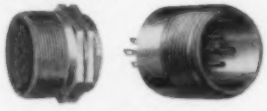
Where Vibration Resistance and Moisture Proofing Are Needed

AN-E Series . . . environment resisting. Replaces "old" AN-M. Meets Specification MIL-C-5015B. Resilient inserts. Completely sealed from cable to cable. Integral clamp and bushing. Grounding lugs. Interfacial sealing with grommet and grommet follower. Available as Interim AN-M with ferrule in place of grommet follower.

The "AN" and associated series connectors offer the

GS (HERMETICALLY-SEALED)

For Use Under Critical Pressure Conditions



Hermetically sealed connectors . . . with steel shells and contacts to withstand high pressures. Available in GS (AN type), KH, RKH, U, BFH, TBFH. Insulation is Can-seal glass material, fused under high temperature to shell and contacts . . . giving *true hermetic sealing* when soldered or brazed to housing.

STEEL SHELL FIREWALL

For Open Flame Protection Wherever High Temperatures Are Involved

AN-K and Cannon FW Firewall Connectors . . . offer you the greatest variety of this type of connector. Cannon made the first firewall connector and continues the leader in the field. Wall—or box-mounting receptacles. Straight or angle 90° plugs. Crimp-on contacts. Inserts of asbestos-filled or glass-filled materials.

CONNECTORS SUITABLE FOR POTTING

For Resistance to Moisture, Fuel Oil, Gasoline, etc.

CA06 and CA3106 Types . . . developed for the Bu Aer Standard AN3106 type minus the end bell. Special plastic "cups" supplied for use as a mold while potting the rear of the connector. Weight saving. Grounding means available. Plastic or resilient inserts.

widest selection of types for all applications to Spec. "MIL"

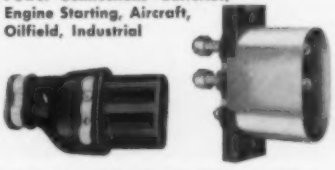
AF, F (VIBRATION PROOF)

For Points of High Vibration Where Extra Strength Is Needed

Vibration Proof CA310*F—CAO*AF Solid Shell, Resilient Insert Connectors . . . Feature extra strong coupling nuts . . . in hex, spline, knurled types for airline use. In wall—or box-mounting, cord-connecting type receptacles. Straight or angle 90° plugs.

AN EXTERNAL POWER

Power Connections—Batteries, Engine Starting, Aircraft, Oilfield, Industrial



CA2551, AN2552, AN3114 and Other Cannon Types Offer Most Complete and Varied Line . . . in single, double, and three contact fittings. Really rugged! Designed and built for safe, positive connection and long-lasting service.

AN ACCESSORIES

Cable Clamps, Conduit Fittings, Dummy Receptacles, Junction Shells, Dust Caps, Bonding Rings, Bushings, Adapters

Featuring High-Quality Materials and Workmanship . . . including AN3057, AN-3057A, AN3420, AN3054, AN3055, AN30-56, AN3058, AN3064, AN3066, AN3068, AN3111, 2120, 2245, 17530, 2209, 2182. Adaptable to all makes of AN connectors.

Cannon Plugs—standard of quality for the industry

W

For Underwater and Severe Moisture Conditions

W Waterproof Series . . . used underwater and on equipment operating in swamps, rivers, lakes, with underground cables—wherever conditions require thoroughly sealed fittings. Exceptionally rugged. AN type inserts. Acme threads on coupling nuts. Special rubber sealing ring. Special heavy duty cable clamp available.

OTHER SERIES . . . Audio Types—External Power Connectors—Switching Types—dc Solenoids—Guided Missile Launching Connectors—Miniatures and Sub-Miniatures.

Write Today for new, completely revised, up-to-date AN10 bulletin!

Since 1915

Please Refer to this Magazine or to Dept. 106

CANNON PLUGS

CANNON ELECTRIC CO., 3209 Humboldt St., Los Angeles 31, Calif. Factories in Los Angeles; East Haven; Toronto, Canada; London, England; Melbourne, Australia. Manufacturing licensees in Paris, France; Tokyo, Japan. Contact our representatives and distributors in all principal cities.

Made by Hadley Products Co., Inc., Marietta, O., the Electronaire filter is used in heating and air conditioning units. Features unique, permanently electrostatic thermo-plastic monofilaments. Grilles are Penmetal expanded aluminum.

They market a permanent filter with the help of expanded aluminum

Sales appeal of an Electronaire filter is permanence . . . and washability. Never needs replacing; cleans easily in water.

The retaining grilles won't rust . . . can't ever loosen . . . yet allow free passage of air and water. That's because they are shaped from remarkably versatile Penmetal expanded aluminum.

When aluminum is slit and stretched to form expanded metal, it retains its inherent advantages —gains the added features of even lighter weight, high percentage of open area and greater strength. This combination of properties offers a tremendous potential for product design and improvement. Particularly where grilles or guards are required.

So, take advantage of Penmetal expanded aluminum in your designs and in your selling. But first, you ought to have a reference copy of bulletin 507 E-M. Write today.

PENN METAL COMPANY, INC.

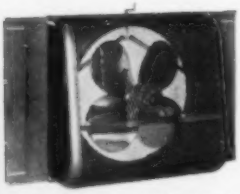
General Sales Office:
40 Central Street, Boston 9, Mass.
Plant: Parkersburg, W. Va.
District Sales Offices: Boston, New York, Philadelphia, Pittsburgh, Chicago, Detroit, St. Louis, Dallas, Little Rock, Seattle, San Francisco, Los Angeles, Parkersburg

METAL MARK Penmetal 1869 OF QUALITY

A FEW OF THE MANY OTHER USES OF EXPANDED METAL:

Air Conditioning Unit Grille (Berns Manufacturing Co., Chicago, Ill.)

Railroad Car Air Filter (Farr Company, Los Angeles, Calif.)



Fan Enclosure (Atlas Tool & Manufacturing Company, St. Louis, Mo.)

PM-115

THIS APEX UNIVERSAL JOINT IS . . .

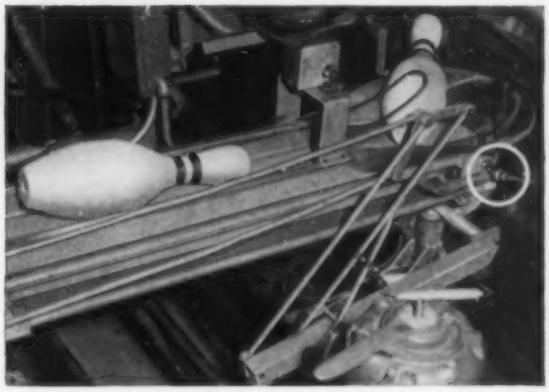
ambidextrous!

b

a

PHOTOGRAPHS COURTESY OF AMF PINSPOTTERS, INC. SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY. PHOTOS TAKEN AT NATIONAL LANES, DAYTON, O.

c



(a) Close-up view of Apex universal joint on AMF Pinspotter distributor drive, showing detail of special bayonet connecter.

(b) Quick-disconnect feature of this Apex universal joint permits fast, easy interchange without use of any tools.

(c) Apex universal joint on distributor drive allows axial movement under load for either right hand or left hand rotation.

The amazing, robot-like action of the AMF Automatic Pinspotter is aided, in part, by an Apex universal joint that allows axial movement under load for either right hand or left hand rotation. This universal joint has a special bayonet hub with a T-slot, designed to meet the unique requirements of the distributor drive on the Pinspotter. The design also permits quick, easy interchange of the connector without use of tools.

Apex, designer-producer of aircraft and industrial universal joints and assemblies, takes particular interest in developing practical solutions to unusual and difficult application problems. Apex covered universal joints, for example, operate efficiently in wet or dry atmospheres, under corrosive or abrasive conditions, and in extremes of temperatures.

If your design problem involves universal joints or assemblies, you should find Catalog 27 and our Application Data Sheets very helpful. Write, on your company letterhead please, for your copy.

APEX

industrial universal joints—3/8″ to 4″ diameters

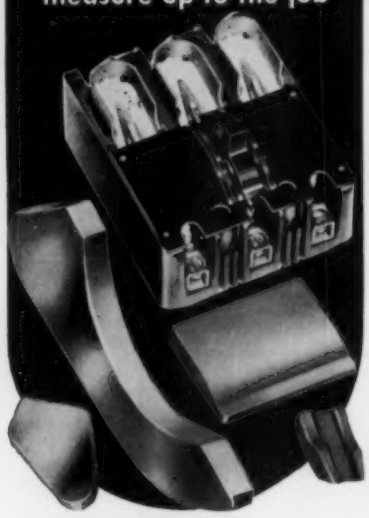
THE APEX MACHINE & TOOL COMPANY

1039 S. Patterson Blvd. • Dayton 2, Ohio

Gibsiloy

SILVER-TUNGSTEN CONTACTS

measure up to the job



- **FOR CIRCUIT BREAKERS**
  The rigid requirements of circuit breakers — compact design, low temperature rise, high interrupting capacity — demand Gibsiloy silver-tungsten electrical contacts.
- **RIGHT PROPERTIES**
  These Gibsiloys have low contact resistance, high current-interrupting capacity, non-welding and other properties which mean trouble-free breaker operation.
- **FLEXIBILITY**
  Gibson's large range of silver-tungsten metal combinations and forms—plus our engineering skill in adapting the right contact to your product—can be a vital asset to you.
- **SERVICE**
  Contacts are our business. Our round-the-clock production devoted to this one field means quick delivery of quality contacts. Let us know your needs.

Gibsiloy
ELECTRICAL CONTACTS

Manufactured by
GIBSON ELECTRIC COMPANY

C358 Frankstown Ave. Pittsburgh 21, Pa.

clutch, simple electric brake, combination electric clutch and brake, and duplex clutch. Range of miniature and small sizes for all these styles runs from $\frac{7}{8}$ to $3\frac{1}{8}$ in. O.D. Simplatrol Products Corp., 24 Salisbury St., Worcester, Mass.

For more information—
Circle 93, inside back cover

Ribbon Cable Assemblies

These cable assemblies are available up to $1\frac{3}{4}$ in. wide with Teflon insulated conductors, ranging in size from 12 to 32 AWG. The system was designed to combine from 2 to 20 conductors or pairs of parallel conductors. It will take a 90 deg bend. There are almost unlimited color codings. Working temperature range is — 250 F to 500 F. Hitemp Wires, Inc., Mineola, N. Y.

For more information—
Circle 94, inside back cover

Hydraulic Control Valves

A line of hydraulic control valves identified as 9700 Series (illustrated) is designed to meet JIC specifications. Operating pressures to 3000 psi can be handled by these units, which have continuous-duty solenoids, pilot-operated. Subplate mounting is used with intermediate choke block, spring return. Open and closed center-type spools are provided, two and three-position, four-way; two-position, two and four way. A range of sizes is manufactured from $\frac{1}{8}$ to $1\frac{1}{4}$ in.

A second new line, 9500-9600

(Continued on page 336)

PRECISION CAMS

from FORD INSTRUMENT

FLAT CAMS 3D CAMS BARREL CAMS

- offered in a variety of types
- with tolerances to ±0.0005"
- for wide range of computing and motion applications

Whatever your computing or motion application, Ford Instrument can make the cam to meet your exacting needs... 3-D Cams, grooved flat cams, external flat cams, grooved cylindrical cams. The Company's unique cam-production facility — and many years of experience — guarantee unmatched performance in this field.

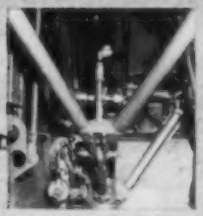
FREE — Fully illustrated data bulletin gives specifications and performance information. Please address Dept. PE.

FORD INSTRUMENT COMPANY
Division of Sperry Rand Corporation
31-10 Thomson Ave.
Long Island City 1, N. Y.

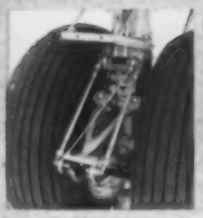
Ford Instrument's standard components

LOCKHEED ELIMINATES TIGHT BEND RADII

WITH CHIKSAN SWIVEL JOINTS



Installed on the nose wheel assembly of the P2V-7, Chiksan Swivel Joints eliminate tight radii bend in rubber hose.



Chiksan Swivel Joints on landing gear of Lockheed's Constellations give metal hydraulic lines the flexibility of rubber.

Located in the landing gear housing of the C-130 these Chiksan Swivel Joints conserve system space, lengthen hose life.

"Better check with Chiksan." That phrase is almost a byword with Lockheed design engineers when the problem of tight bend radii develops. For good reason, too. Lockheed engineers have found time and again that Chiksan has the experience and the facilities to provide a compact lightweight swivel joint to meet their needs quickly, efficiently. Check with Chiksan. Remember that phrase the next time you want a fast, right answer to your bend radii problem.

CHIKSAN

A SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

fmc

FOR CATALOG WRITE DEPT. 17

CHIKSAN COMPANY—BREA, CALIFORNIA • CHICAGO 5, ILLINOIS • NEWARK 2, NEW JERSEY

Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Subsidiaries: Chiksan Export Company • Chiksan of Canada, Ltd.

R B & W FASTENER BRIEFS

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY

Technical-ities

By John S. Davey

The Proper Loading of Bolts

The pre-load, or residual tension, in a tightened bolt means more to assembly strength than the actual strength of the bolt itself.

In a joint, a bolt torqued to its proper load level resists a maximum amount of external load without loosening. Designers can take advantage of this fact and assure better results, and at the same time, cut costs.

For example: One designer calculated that truck frames needed high strength bolts at least ½" in diameter. So he used ⅝". But on the assembly line, these were being torqued to 100 ft.-lbs. whereas they needed at least 200 ft.-lbs. for proper residual tension. The ½" bolt at 100 ft.-lbs. would actually have given the stronger assembly and at less cost.

In another case, the bucket on earth moving equipment was always coming loose. The design engineer kept increasing the size of the bolt up to 1¼", but to no avail. The impact wrench used was supplying far too little torque for this size. We suggested a return to the original ¾" bolt used, set up to 350 ft.-lbs. torque. It solved the problem.

In short, the more you stress a bolt within its elastic limit, the greater its ability to stay tight and make a strong assembly.

Symmetrical flow lines assure strong bolt heads

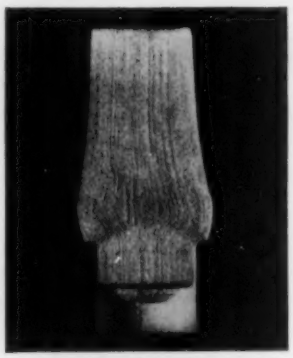


Photo of perfect cold worked blank after first upset.

Effect of improper forming is a poor head like this.

IN THE manufacture of bolts and cap screws, the first upset of metal is a vital one. It determines the flow lines in the bulb which will form the head. A symmetrical flow assures no laps and, therefore, no weak spots or cracks in the final upset of the head.

MACHINE OPERATOR'S SKILL VITAL

The upper photo shows a longitudinal section of a blank after the first upset and on its way to becoming an RB&W standard bolt. Note the even distribution of flow lines. This bulb will become a perfect head.

The lower photo shows what can happen with poor tools, inexperienced operators or without precision setup of the cold headers. Note how pronounced is the unbalanced flow pattern which resulted from a bulb with just a minute defect.

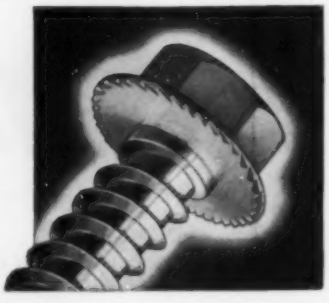
DEPENDABLE FASTENERS

Cap screws and bolts also get a bright smooth finish from the right kind of cold forming. But above all, they offer the designer low cost fasteners with sound internal structure. Standard RB&W fasteners can be loaded to their proper level —become a strong point in any assembly.

For help on your fastener problem, contact Russell, Burdsall & Ward Bolt and Nut Company. Plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

The Only Screw That Stays Tight

The continual heating and cooling caused loosening of handle screws on the flat irons of one manufacturer. Every type tried failed to stay tight until RB&W's unique Spin-Lock tapping screws were used. This solved the problem. Their hardened teeth lock into the surface, require more torque to loosen than to tighten. One piece fasteners, they speed assembly time.



"SPEEDWALK"*SYSTEM HANDLES MASS MIGRATION DAILY

To speed commuters from tube trains to surface lines at Jersey City, New Jersey, the Hudson & Manhattan Railroad installed a passenger conveyor capable of moving 10,800 passengers hourly.

Built by Stephens-Adamson Mfg. Co. and Goodyear Tire & Rubber Company, the Speedwalk* system travels 227 feet at 120 feet per minute on spun rollers formed from B&W Electric-Resistance-Welded Steel Tubing. On their weary homeward journey passengers ride up a 10 percent grade, formerly known as "cardiac climb", for the first 137 feet.

Because of its known characteristics, the choice of B&W Tubing was natural for this service.

If you plan to design or build equipment requiring tubing . . . seamless or welded . . . carbon, alloy or stainless steel . . . for pressure or mechanical use, send for Mr. Tubes. He can aid you in selection and help you get the most for your money. *Or write for Bulletin 361.* The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

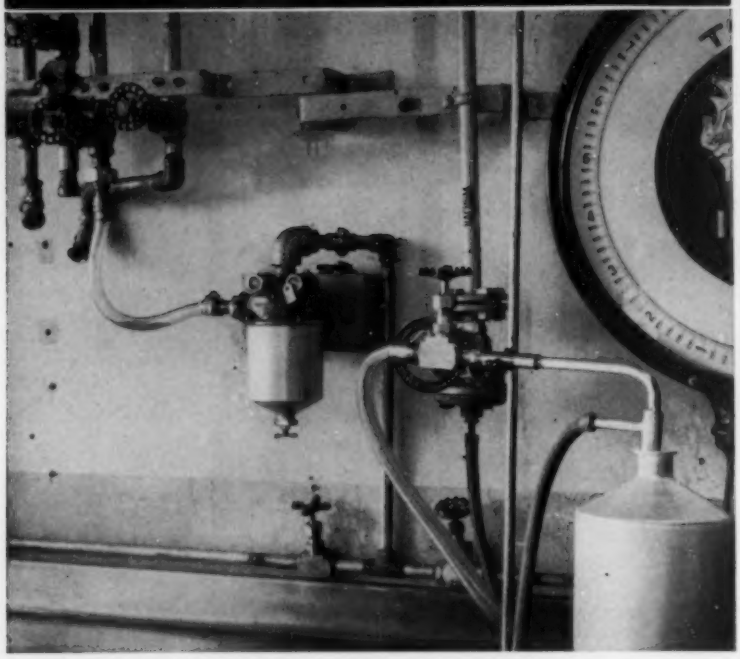
*Trade-Mark

B&W
TUBULAR PRODUCTS DIVISION

TA-5057(M)

Seamless and welded tubular products, seamless welding fittings and flanges—in carbon, alloy and stainless steels

FILTER FORUM



Question:

"How do you filter a Vitamin Solution?"

A manufacturer of vitamins experienced considerable difficulty with filtration in one of his vitamin processes. The filter element used clogged after a mere 5 gallons of material had gone through. How could he eliminate frequent cleaning and maintenance and still achieve a clear, sparkling syrup?

Answer:

Ingenuity

Purolator recommended their PR-255-15 Aviation Fuel Filter. This unit is made of aluminum and contains a pleated paper Micronic® element. The filter has been extremely satisfactory. One cartridge filters 100 gallons before servicing . . . nearly 20 times more than the previous filter, with an even finer degree of filtration. Since the cartridge is of the disposable type, it is removed and replaced after each run, cutting time, handling and loss to a minimum. The excellent results of this application of a standard aviation type filter to a highly specialized operation demonstrates the advantages of Purolator's exceptional experience in solving filtration problems.

MAIL COUPON FOR DESIGN INFORMATION

PUROLATOR

FIRST in the field of filtering

Dept. D12-829 Purolator Products, Inc., 970 New Brunswick Ave., Rahway, N. J.

Please send me the following filter information:

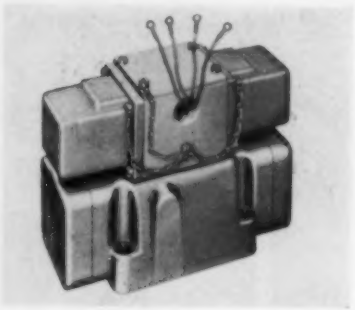
_____ Purolator's new "Filtration Manual for Designers". I'm enclosing 25¢ to cover postage and handling.

_____ Enclosed is a description of our filter problem. How should we solve it?

NAME_____ TITLE_____

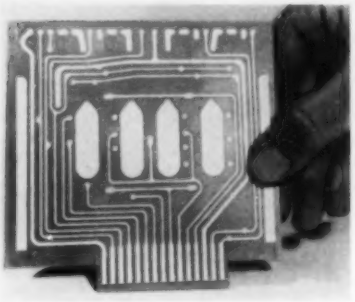
COMPANY_____ ADDRESS_____

CITY_____ ZONE_____ STATE_____



Series, handles operating pressures to 1500 psi. With heavy-duty, continuous service solenoids, pilot operated, either two-position, four-way or three-position, four-way types are available. Sizes range from ¼ to 1 in. Logansport Machine Co., Inc., Logansport, Ind.

For more information—
Circle 95, inside back cover



Epoxy Glass For Printed Wiring

This material is primarily for electrical and electronic uses. Surface resistance is 1,000,000 megohm. The laminate is available in sheet sizes 39 by 47 in., with thicknesses from 3/32 to ½ in. Standard finish is a semi-gloss and standard color is natural (light brown). Available with copper foil on one or both sides. National Vulcanized Fibre Co., 1056 Beech St., Wilmington 99, Del.

For more information—
Circle 96, inside back cover

Single-Worm, Right Angle Gearmotors

These units are available in ratings ¼ to 30 hp, for a-c or d-c service. Worms, integral with the shafts, are

(Continued on page 339)

SMALL MIRROR PART REFLECTS 66% SAVING: GRC DIE CASTING ELIMINATES SCRAP LOSS

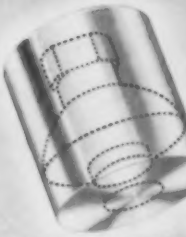
Brass screw machine part made from bar-stock meant big scrap loss, high cost; Gries die cast part means no scrap loss; costs only ⅓rd as much!

This rear view mirror component was an expensive part of the assembly when made of brass because so much costly metal was completely lost in machining (see diagram). Gries' die casting of the same part for Roberk Mfg. Co., Norwalk, Conn., completely eliminates the scrap loss. In addition, Gries, design flexibility permitted casting the part with a "material-saver," for further cost reduction. The brass part actually was 3 times more costly than the Gries zinc die cast part!

GRC's exclusive die-casting methods produce finished tiny parts, trimmed,ready-for-use, in one high-speed automatic operation . . . at low, *low* tool cost. The rear view mirror part is being die cast less wastefully, less expensively, and more uniformly, at high production rates.

Gries' unusual techniques and special facilities permit almost unlimited design latitude. No part is too small—maximum weight, ½ ounce; maximum length 1¼ inches. Economical mass production — from 100,000 to many millions — assures lowest costs.

Send for your copy of Gries' new informative Die Casting Bulletin



BRASS SCREW MACHINE PART
showing scrap loss

GRC DIE CASTING
designed for minimum metal usage

GRC DIE CASTS GEARS AND PINIONS IN ONE PIECE FOR LOWER UNIT COSTS

Lower cost, improved design, faster production is possible because GRC gears and pinions are die cast in *one* piece. These one-piece zinc alloy assemblies can be die cast with shafts or center holes, or in combination with cams, hubs, spacers, flanges, etc. Many combinations are available from stock dies for less precise applications at no tool charge. Special designs and close-tolerance requirements are produced at nominal tool charges.

Maximum size of Gries' gears and pinions is 1-5/16" O.D. x 1/16" face width; on the smaller diameters wider faces can be furnished. They are available in quantities from 100,000 to millions. Write for catalog sheet, samples.

GRC MAKES WIDEST RANGE OF WING NUT TYPES AND SIZES

Mass produced in the widest selection of stock sizes to fit all cost and application requirements, GRC wing nuts are also available in many types to meet unusual requirements. These include wing nuts with high, low or narrow wings to meet space limitations — and with serrated base for locking action, in many applications. All have finger-grip recessed wings, exclusive with Gries.

GRIES HAS COMPLETE FACILITIES FOR SECONDARY OPERATIONS

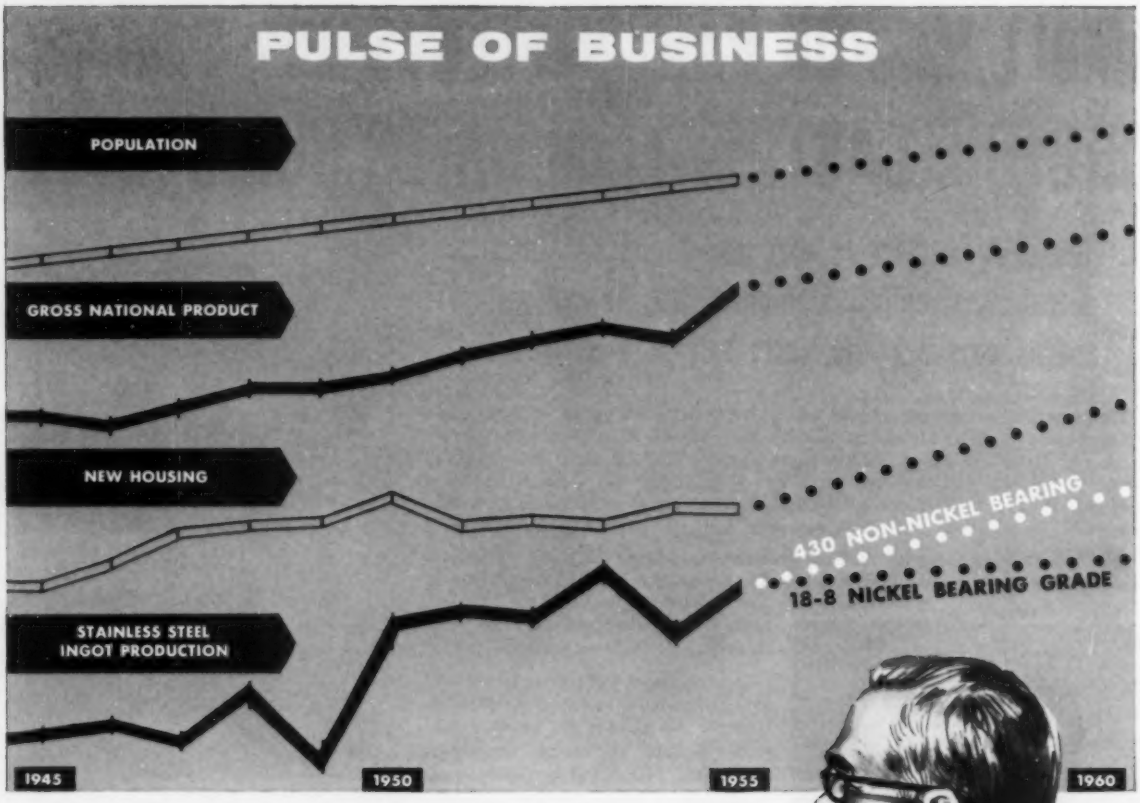
In most cases, Gries' die cast zinc alloy parts need no secondary operations. However, GRC has full facilities for tapping, threading, drilling, reaming, special machining and assembling, when needed. Gries' Finishing Department has special mass-production facilities for the application of surface finishes to small die-cast parts. Special methods are used for most commercial finishes, including electroplating, barrel-finishing and chemical treatments.

WORLD'S FOREMOST PRODUCER OF SMALL DIE CASTINGS

GRIES

GRIES REPRODUCER CORP.

159 Beechwood Ave., New Rochelle, N. Y. • NEw Rochelle 3-8600



Now! you can grow with your markets

. . . because Washington Steel Corporation has taken two big steps forward:

1. **Making available an adequate and dependable source of supply for Type 430 stainless steel.**
2. **Reducing the base price of Type 430 sheets to provide you with savings of $200 per ton as compared to Type 302 stainless sheets.**

Many designers and fabricators who are currently using Type 302 stainless can, in numerous applications, specify Type 430 straight chromium stainless and take advantage of the 10 cents per pound difference in base price. Some of our customers are already saving more than $200 per ton using our 430 MicroRold stainless steel.

The steel industry estimates that 50% of all stainless sheet applications could satisfactorily employ Type 430, the least expensive of all stainless grades, as an economical and practical material. When properly applied, Type 430 has all the desirable qualities of beauty, corrosion resistance, strength, long life and low maintenance that no other material, *except* stainless, can offer.

We are currently producing our MicroRold Type 430 sheets in thicknesses .005″ to .109″ with 2B or 2D finishes; and in thicknesses .010″ to .109″ in No. 3, 4 and 7 finishes.

Type 430 sheets are immediately available for delivery without restriction.
We are supplying the 18-8 grades against rated orders only.

Washington Steel
Corporation
8-G WOODLAND AVE., WASHINGTON, PA.

Send for your copy, "Care and Use of 430 Stainless"

made of hardened alloy steel and threads are precision ground. Positive oil seals between motor and gear and on the output shaft prevent escape of oil or contamination of lubricant. Elliott Co., Jeannette, Pa.

For more information—
Circle 97, inside back cover

Data Tables

These tables are printed on adhesive-backed, lacquer-coated paper, measuring 2 x 17 in. They can be affixed to drafting board, work light, pull-out desk shelf or other easy-to-see surfaces. Data provided includes, dimensions of various standard types of fastenings, decimal equivalent, wire, sheet metal and tubing gages, information on tap drills and twist drills. Timber Top Products, P. O. Box 14, Freeport, N. Y.

For more information—
Circle 98, inside back cover

Miniature Portable Controller

Consisting essentially of an electronic switch, the unit will control up to 500 w of power, either delivered at 115 v, ac, 60 cps, or switched by its internal contacts. A self-contained rotary switch allows rapid panel selection of any of four output functions, whether it be power supplied normally on or normally off, or switching normally open or normally closed. A model is available at reduced cost which internally provides, as a single output function, any one of the four control actions mentioned earlier.

A variety of pickups are suitable for use as input sources for the controller. Antron Engineering, Inc., 1254 W. 6 St., Los Angeles 17, Calif.

For more information—
Circle 99, inside back cover

GLOBE PRECISION
actual size
MIDGET A.C. MOTORS
PACK A GIANT PUNCH!
HYSTERESIS
VOLTAGE
CAPACITOR M.F.D.
PART NO.
GLOBE INDUSTRIES, INC.
actual size
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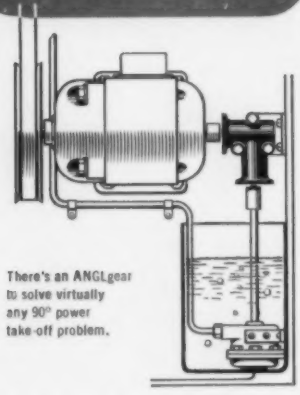
takes power around corners neatly!



There's an ANGLgear to solve virtually any 90° power take-off problem.

Simple, compact, permanent—that's ANGLgear, the standardized right-angle drive. ANGLgear is versatile; can be mounted four different ways; thus is easy to design into your power transmission system. ANGLgear has high capacity: Model 340, rated 3 hp at 1200 rpm, will transmit a torque of 2500 lb. in. ANGLgear is sturdy; has tough Coniflex* gears, antifriction bearings, and is lubricated for life.

ANGLgear comes in 1/3, 1 and 3 hp sizes, with 1-1 or 2-1 gear ratios and 2- or 3-way shaft extensions.

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*TM The Gleason Works, Rochester, N.Y.

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CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover. For those catalogs and bulletins available only when requested on company letterhead, see page 357.

Die Casting Standards—Publication AD (I-M7-56T), 9 pp, contains engineering considerations under following headings: composition and properties of aluminum castings; characteristics of aluminum alloys; alloy cross reference chart; composition and properties of copper-base castings; brass die castings and alloy selection; composition and properties of magnesium castings; and characteristics of magnesium alloy die castings. American Die Casting Institute, Inc., 366 Madison Ave., New York 17, N. Y.

Circle 100, inside back cover

Connectors—Bulletin 26A, 2 pp, describes miniature continental connectors, including code number designations. DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle 101, inside back cover

Pumping—Booklet, 35 pp, discusses pumping system problems, deals with rotary gear pumps and contains data on hydraulic and fluid transfer problems, friction loss, viscosity, pump construction and design. G. D. Roper Corp., Rockford, Ill.

Circle 102, inside back cover

Variable Speed Drive—Folder, 4 pp, describing speed reducers of V-belt type. Foote Bros. Gear & Machine Corp., 4545 S. Western Blvd., Chicago 9, Ill.

Circle 103, inside back cover

Speed Reducer—Bulletin LMA, 15 pp, describes in-line reducers and drives suitable for use with foot-mounted motors. Foote Bros. Gear & Machine Corp., 4545 S. Western Blvd., Chicago 9, Ill.

Circle 104, inside back cover

Flow and Level Sensing—Bulletin 55D, 2 pp, describes devices that can indicate a lack of material supply or flow in a handling operation. Richardson Scale Co., Van Houten Ave., Clifton, N. J.

Circle 105, inside back cover

Relays—Catalog C-7, 19 pp, includes telephone AN approved series, keying, midget, hermetically sealed relays and steppers, motor starters and contractors, timers and sensitive relays in popular contact arrangements and coil ratings. Relay Sales, Inc., Box 186—W. Chicago, Ill.

Circle 106, inside back cover

Beryllium Copper—Catalog, 12 pp, available casting alloys, properties, advantages, casting and processing techniques, Beryllium Corp., Reading, Pa.

Circle 107, inside back cover

Plastic Laminates—Brochure, 8 pp, contains descriptions of base materials, binders, sizes, tolerances, fabricating qualities and types available. Farley & Loetscher Mfg. Co., Dubuque, Iowa.

Circle 108, inside back cover

Variable Pulleys—Catalog 60-A, 18 pp, describes adjustable and combination pulleys, including accessories, along with ratings and dimensions. Lewellen Mfg. Co., Columbus, Ind.

Circle 109, inside back cover

Power Take-offs—Bulletin 308, 8 pp, provides horsepower and torque capacities, side pull limitations, and dimensions for all take-off clutches. Twin Disc Clutch Co., Racine, Wis.

Circle 110, inside back cover

Subminiature Switches—Catalog 75A, 16 pp, describes 56 different switches, auxiliary actuators and switch assemblies. Micro Switch, Freeport, Ill.

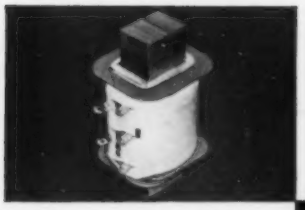
Circle 111, inside back cover

Miniature Universal Joint—Bulletin, 1 pp, describes joint said to have zero backlash and operating on welded ball assembly. Falcon Machine & Tool Co., Inc., 209 Concord Turnpike, Cambridge 40, Mass.

Circle 112, inside back cover

Laminated Metals—Booklet, 8 pp, describes laminated strip, wire, tubing of precious, semi-precious and other

(Continued on page 343)



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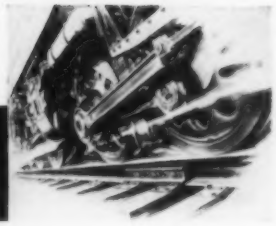

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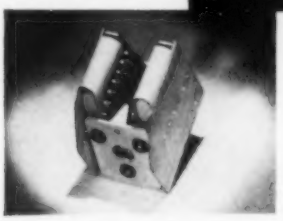

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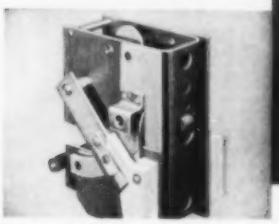

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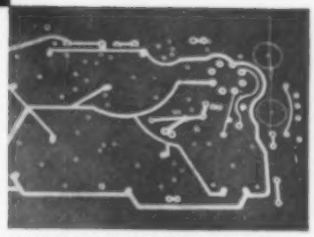

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alloys. Improved Seamless Wire Co., 775 Eddy St., Providence 5, R. I.
Circle 113, inside back cover

Power Transmission Equipment—Brochure, 12 pp, describes flexible couplings, variable speed pulleys and transmissions, universal joints and motor bases. Information includes operating data, horsepower ratings, sizes and types. Lovejoy Flexible Coupling Co., Dept. PEN, 4800 W. Lake St., Chicago 44, Ill.
Circle 114, inside back cover

Stainless Steel Castings—Bulletin 156-H, 2 pp. Chart correlates ACI designations with corresponding AISI type numbers and ASTM designations. Empire Steel Castings, Inc., Reading, Pa.
Circle 115, inside back cover

Indexing Tables—Catalog 301, 24 pp, describes tables, power units, controls, mounting plates, indexing mechanisms. Ferguson Machine & Tool Co., Inc., P.O. Box 5841, St. Louis 21, Mo.
Circle 116, inside back cover

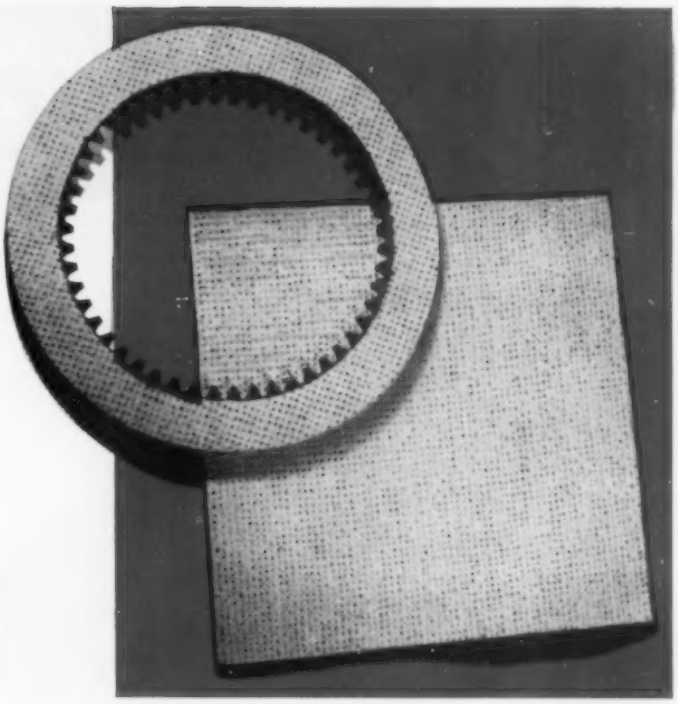
Sprockets—Catalog 200, 14 pp, describes hub, plate, fixed bore, tapered bushing types along with roller chain. Cullman Wheel Co., 1344 Altgeld St., Chicago 14, Ill.
Circle 117, inside back cover

Relief Valves—Catalog 551, 16 pp, contains information on selection, design and function. Fluid Controls, Inc., 1284 N. Center St., Mentor, Ohio.
Circle 118, inside back cover

Explosion-proof Motors—Bulletin GEA-6341, 8 pp, discusses design and maintenance of induction motors, 1 through 30 hp, for use in hazardous locations. General Electric Co., Schenectady 5, N. Y.
Circle 119, inside back cover

Leather Packings—Handbook, 60 pp, discusses design and application. Includes tables listing recommended dimensional standards for various types of mechanical packings. Mechanical Leather Packing Div., National Industrial Leather Assn., 320 Broadway, New York 7, N. Y.
Circle 120, inside back cover

Tolerances for Printed Circuits—Bulletin P-9, 2 pp, includes diameter tol-
(Continued on page 345)



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crances of unplated and plated holes, location tolerances between holes, hole-to-pattern tolerances, alignment (front-to-back) tolerances, circuit pattern to outside dimension tolerances, overall dimension tolerances, holes to outside dimension tolerances, line width and spacing tolerances, plating tolerances. Photocircuits Corp., Glen Cove, N. Y.

Circle 121, inside back cover

Decimal Equivalents—Combination decimal equivalent chart and calendar dated for July 1956 through June 1957. Dayton Rogers Mfg. Co., Minneapolis 7, Minn.

Circle 122, inside back cover

Motors and Generators—Folder, 4 pp, describes drives of ½ to 125 hp. Marble-Card Electric Corp., Gladstone, Mich.

Circle 123, inside back cover

Canned Motor Pump—Bulletin 1060, 4 pp, describes pump less than 8 in. long, mounting directly in the pipeline. Chempump Corp. Station N, 1300 E. Mermaid Lane, Philadelphia 18, Pa.

Circle 124, inside back cover

Magnetic Power Transmission—Bulletin 226-D, 7 pp, describes magnetic clutches and brakes, providing selection dates, ratings, dimensions. Stearns Magnetic Inc., 612 S. 28th St., Milwaukee, Wis.

Circle 125, inside back cover

PVC Pipe and Fittings—Memorandum, 8 pp, covers corrosion resistance, general properties, fabricating characteristics. Peter A. Frasse & Co., Inc., 17 Grand St., New York 13, N. Y.

Circle 126, inside back cover

Heating Units—Catalog, 20 pp, describes electrical strip, ring, straight rod, finned, immersion, urn-type heating devices. Tuttle & Kift, Inc., 1823 N. Monitor Ave., Chicago 39, Ill.

Circle 127, inside back cover

Trip Controls—Catalog 65a, 11 pp, describes electric clutch controls for industrial machinery. Micro Switch, Freeport, Ill.

Circle 128, inside back cover

Hydraulic Pump Motors—Bulletin 22, 7 pp, describes rotary gear pumps used to convert fluid pressure and volume

(Continued on page 346)

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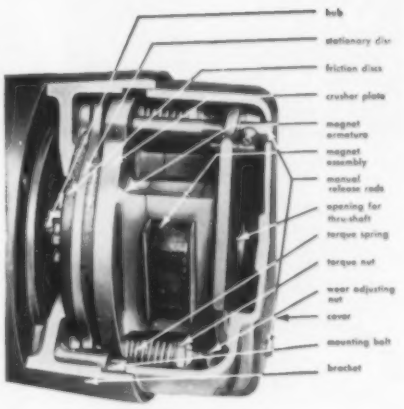

THRU-SHAFT DESIGN

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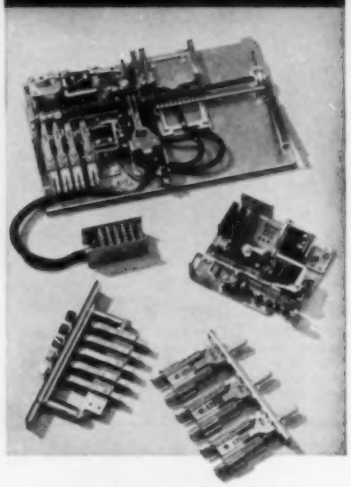

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Catalogs and Bulletins.....continued

into torque or horsepower. G. D. Roper Corp., Rockford, Ill.

Circle 129, inside back cover

Leather Packings—Folder, 4 pp, describes U and V-packings, cup and flange packings. Chicago Belting Co., Washington and Green St., Chicago 7, Ill.

Circle 130, inside back cover

U and V-Packings—Folder, 4 pp, describes line of interchangeable rubber, leather and fabric packings. Chicago Belting Div., Chicago-Atlas Mfg. Corp., 125 N. Green St., Chicago 7, Ill.

Circle 131, inside back cover

Check Valves—Folder, 4 pp, describes valves for gas and fluid control. Kepner Products Co., 7321 W. 59 St., Summit, Ill.

Circle 132, inside back cover

Limit Switches—Bulletin 356, 4 pp, on machine tool limit switches describes 19 contact arrangements available with seven models. R. B. Denison Mfg. Co., 102 St. Clair Ave., N. W., Cleveland 13, Ohio.

Circle 133, inside back cover

Visual Aids—Catalog, 20 pp, describes method of "drawing" charts, graphs, and layouts with pressure sensitive tapes and templates. Commonly recognized lines, shapes, bars, symbols and die cut office furniture templates are pre-printed on tapes or sheets with adhesive backing. Chart-Pak, Inc., 100A Lincoln Ave., Stamford, Conn.

Circle 134, inside back cover

Wire-Wound Resistors—Bulletin B-5, 4 pp, has data on types, construction, tolerance, dimensions, temperature coefficient, derating. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.

Circle 135, inside back cover

Miniature Flexible Couplings—Bulletin MC-100, 4 pp, has dimensional drawings, material specifications, dimensions, bore size and list prices. Thomas Flexible Coupling Co., Warren, Pa.

Circle 136, inside back cover

Chrome Surface Treatment of Steel—Bulletin 5, 8 pp, describes process for increasing heat, wear and corrosion re-

(Continued on page 348)

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LIMBEROLLER IDLER

JOY'S NEW BELT CONVEYOR IDLER

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Scientist at control box of a Sanford-Bennett High-H-Permeameter measures hysteresis loop of Indox ceramic magnet.

How temperature affects magnets

An interview with Dr. Rudolf K. Tenzer, scientist, The Indiana Steel Products Company

BECAUSE PERMANENT MAGNET remanence changes, resulting from varying temperatures, often necessitate corrections, compensations, or allowances, Dr. Tenzer undertook a series of studies on the subject. Some of the data used by him in answering the questions posed below resulted from work sponsored by the Wright Air Development Center of the U. S. Air Force. Reprints of an article by Dr. Tenzer on the subject are available by writing The Indiana Steel Products Co., Dept. C-8, Valparaiso, Ind.

Question: How does the remanence of permanent magnets vary with temperature?

Answer: Normally, remanence decreases with an increase in temperature . . . becoming zero at the Curie point, where all ferromagnetic properties vanish.

Question: Does a change in temperature result in a permanent change in remanence?

Answer: Not necessarily. Investigations which we have conducted show that temperature effects on ferromagnetic materials reveal both non-reversible and reversible variations.

Question: Can the result of these influences be evaluated?

Answer: Proper measuring techniques will evaluate the non-reversible variations as well as the reversible variations.

Question: Are non-reversible variations permanent changes in the remanence of a magnet?

Answer: Non-reversible variations are permanent until the initial remanence is restored by remagnetizing. This effect is not the same as irreversible metallurgical changes which prevent restoration of initial remanence by remagnetizing.

Question: What are reversible variations in remanence?

Answer: When a magnet has been stabilized for a certain temperature range, remanence variations within this temperature range are reversible.

Question: How are magnets stabilized for a given temperature range?

Answer: The magnet is exposed to repeated temperature cycling over a given range until the non-reversible variation becomes zero and remanence at room temperature remains the same for each additional cycle.

Question: Can the amount of remanence variation with temperature be predicted?

Answer: Our experiments in this field have produced quantitative results which can be used in predicting both the reversible and the non-reversible variations in remanence resulting from temperature change.

Question: Over what temperature range can these measurements be applied?

Answer: Our initial work in this field has been carried out in the temperature range from —60°C to 350°C.

Indiana expands research and production facilities

Currently under construction at Valparaiso, Ind., is a half-million dollar addition to the main plant of The Indiana Steel Products Co. The new structure will provide facilities for expanded research of magnetic materials, and increased production of Indox ceramic permanent magnets.

"Cattle Magnets" protect Bossie from stomach-aches

Cows often consume nails, staples and wire with their food. This causes a disorder called "hardware disease." To prevent it, you can feed Bossie an Indiana "Cattle Magnet." The magnet remains in her first stomach, gathering the stray metal. This keeps it from passing to her other stomachs (she has four, you know) where it can cause great distress.

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VALPARAISO, INDIANA
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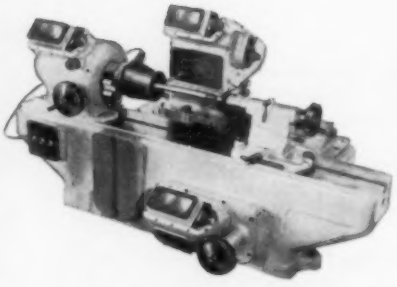

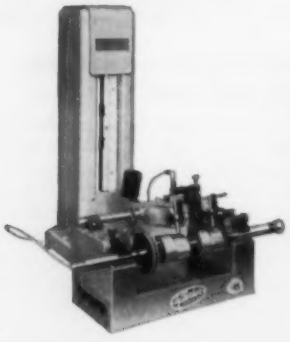

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sistance of steel by high temperature diffusion of chromium into the surface. Chromalloy Corp., 450 Tarrytown Road, White Plains, N. Y.

Circle 137, inside back cover

Panel Fasteners—Catalog, 10 pp, describes three main types of quarter-turn fasteners and their applications for general, light, or heavy duty. Southco Div., S. Chester Corp., 200 Industrial Highway, Lester, Pa.

Circle 138, inside back cover

Rotary Switch—Data Sheet, 2 pp, describes twelve-position subminiature switch. International Instruments, Inc., P.O. Box 2954, New Haven, Conn.

Circle 139, inside back cover

Shock and Vibration Mountings—Bulletin 1000, 8 pp, describes metal mesh cushion unit for heavy machinery. Robinson Aviation, Inc., Teterboro, N. J.

Circle 140, inside back cover

Machine Tool Clutch—Bulletin, 4 pp, describes applications where many output speeds are desired with a constant input speed. ITE Circuit Breaker Co., 19th & Hamilton St., Philadelphia 30, Pa.

Circle 141, inside back cover

Vibration Isolation—Catalog SVC-55, 4 pp, describes basic theory of vibration isolation and shock absorption and shows various types of machinery vibration, gives basic data, formulae and graphs. T. R. Finn & Co., Inc., 200 Central Ave., Hawthorne, N. J.

Circle 142, inside back cover

Servo Motors and Generators—CATALOG 7, 16 pp, consists of characteristics charts, performance data, dimensional drawings, and complete specifications. G-M Laboratories Inc., 4300 N. Knox Ave., Chicago 41, Ill.

Circle 143, inside back cover

Electric Furnace Iron—Folder 15, 4 pp, describes principal physical properties of two grades of unalloyed iron. Folder is illustrated with photomicrographs of graphite distribution and examples of castings. Belle City Malleable Iron Co., Racine, Wis.

Circle 144, inside back cover

Beryllium Copper Strip—Bulletin, 4 pp, contains charts, tables and graphs giving data on properties, composition

(Continued on page 351)

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ENGINEERING BULLETIN
ON MICRO-BEARINGS
Miniature Instrument Ball Bearings

NEW HAMPSHIRE BALL BEARINGS, INC.
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Subject: RADIAL AND AXIAL PLAY

This bulletin explains the interrelation between radial play, axial play and contact angle in small instrument type ball bearings, and assists in specifying these characteristics correctly for typical applications.

DEFINITIONS

Radial play is the maximum possible radial displacement of the inner ring with respect to the outer ring when the bearing is unmounted. *Axial play* is the maximum possible axial displacement of the inner ring with respect to the outer ring when the bearing is unmounted. *Contact angle* is defined as the angle between a plane perpendicular to the bearing axis and a line connecting the two points on a given ball where it makes contact with the raceways under a condition of pure thrust load.

Radial play, axial play and contact angle are geometrically interrelated, but since radial play is the most readily measurable, it is the characteristic usually specified.

In *Fig. 1*, values of axial play resulting from a given radial play and ball size, are given for reference purposes.

SPECIFYING RADIAL PLAY

Two fundamental considerations must be established before arriving at a correct radial play specification: (1) the direction of the load imposed on the bearing, and (2) the axial play control, if necessary for the proper functioning of the unit. This is ultimately a problem of considering the contact angle resulting from a given radial play. High radial play is associated with high contact angle. This relationship is illustrated on *Fig. 2*.

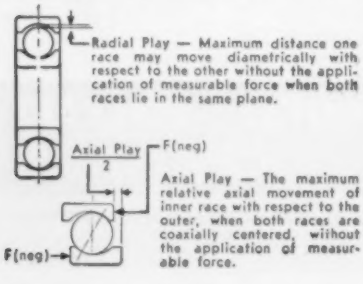
TYPE OF LOAD

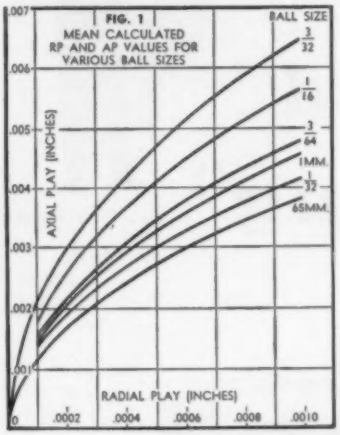
If there is a measurable *axial load*, such as is encountered with bevel gearing, or in an application such as illustrated in *Fig. 3*, the bearings should operate at a high contact angle. Under such circumstances, a radial play of .0005 to .0008 is recommended.

If the application involves a *pure radial load*, such as in the case of spur gears *(Fig. 4)*, there is no concern with contact angle, since it will be zero.

LOW RADIAL PLAY

Functional requirements of the application will dictate whether the radial play is low or standard. However, before *low* radial play is specified, the following factors must be considered:


Radial Play — Maximum distance one race may move diametrically with respect to the other without the application of measurable force when both races lie in the same plane.
Axial Play
F(neg)
2
Axial Play — The maximum relative axial movement of inner race with respect to the outer, when both races are coaxially centered, without the application of measurable force.
F(neg)



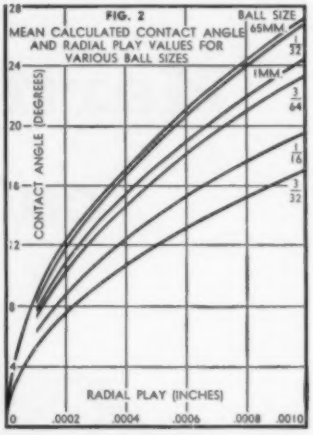


FIG. 5. *Typical Micro-Bearing of the shielded type shown in exploded, cut-away and fully assembled views.*

1. *A bearing with low radial play should not be subjected to interference fitting. This causes reduction in radial play which may create excessive preload resulting in early bearing failure.*
2. *Low radial play results in a low allowable angle of misalignment. An important feature of a ball bearing is its ability to adjust itself internally to possible housing misalignment, particularly when through-boring is not possible.*

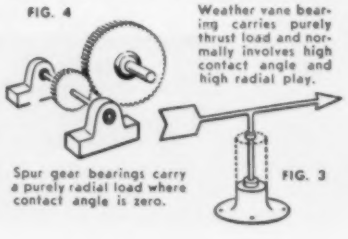
There is one situation, however, where low radial play is recommended. If the bearing is to be subjected to very high repetitious radial shock loads, low radial play minimizes the possibility of bearing damage by distributing the load over a greater number of balls.

AXIAL PLAY CONTROL

If a design calls for axial play values of .002 or less and the bearings are to be used to limit axial travel, it is *not* good practice to achieve this by specifying low radial play. The design should provide for external means of adjustment such as shims. For such cases, the recommended radial play is from .0005 to .0008.

Great care should be exercised if any means other than a calibrated spring is employed to take out *all* axial play. Preloading, with its many complications, may result. Zero axial play automatically yields zero radial play. A high radial play, such as .0005 to .0008, is recommended in cases where axial play is to be reduced to zero by external means.

FIG. 4



Weather vane bearing carries purely thrust load and normally involves high contact angle and high radial play.

Spur gear bearings carry a purely radial load where contact angle is zero.

FIG. 3

RADIAL PLAY SPECIFICATION

There is a misconception among many bearing users that radial play is automatically considered under the ABEC classification. Such is not the case.

However, standard "MICRO" bearings are assembled with a radial play of not less than .0002 nor greater than .0008, unless so ordered. If this range of .0002 to .0008 is acceptable in the application, it is recommended that *No Radial Play Specification* be placed on the bearing.

Radial play is specified most conveniently by a tolerance range. Thus, while the radial play of a given bearing might be .00036, it is more convenient to represent this value as .0002 to .0005. Detailed instructions for specifying other than standard radial play values are incorporated in our catalog.

Since radial play is determined during the bearing manufacturing, specifications of other than standard values should be considered carefully at the design stage, as it may result in delay in assembly and delivery.

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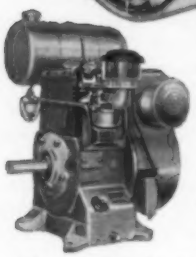

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and tempers available, and forming properties for a high conductivity alloy. Beryllium Corp., Reading, Pa.

Circle 145, inside back cover

Nickel Alloy Tubing—Catalog 12, 20 pp, tabulates specific mechanical properties and chemical compositions of 13 analyses of nickel and nickel alloy tubing. A table of standard production limits includes maximum and minimum walls for each tubing analysis in each standard size. Superior Tube Co., 1556 Germantown Ave., Norristown, Pa.

Circle 146, inside back cover

Hose Fittings—Catalog 18, 7 pp, covers couplings, clamps, nipples, valves and manifolds. Hose Accessories Co., 2700 N. 17 St., Philadelphia 32, Pa.

Circle 147, inside back cover

Blind Rivets—Bulletin TL-118, 4 pp, has specifications and design details of rivets, as well as listing of proper guns and heads for applying them. Townsend Co., P.O. Box 237-Z, New Brighton, Pa.

Circle 148, inside back cover

Perforated Metals—Stock list, 6 pp, describes industrial and decorative perforated metal sheets carried in stock at warehouses. Information as to sheet sizes, type and gage of metal and percent of open area is given. Perforated patterns are illustrated actual size. Harrington & King Perforating Co., Inc., 5617 Fillmore St., Chicago 44, Ill.

Circle 149, inside back cover

Back Pressure Control—Bulletin 544, 6 pp, shows device in pressure sensing, pilot, control valve circuits. Industrial Engineering Corp., 525 E. Woodbine, Louisville 8, Ky.

Circle 150, inside back cover

Rotating Limit Switch—Bulletin 5605, 4 pp, contains voltage rating charts, dimensional diagrams, wiring illustrations, application photos and list prices. Furnas Electric Co., 1050 W. McKee St., Batavia, Ill.

Circle 151, inside back cover

Variable Speed Drive—Bulletin 1600-B7P, 14 pp, contains information about operating principle, design, component parts, definition of engineering terms and formulas, and includes selection tables and illustra-

(Continued on page 352)

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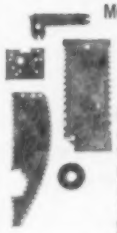

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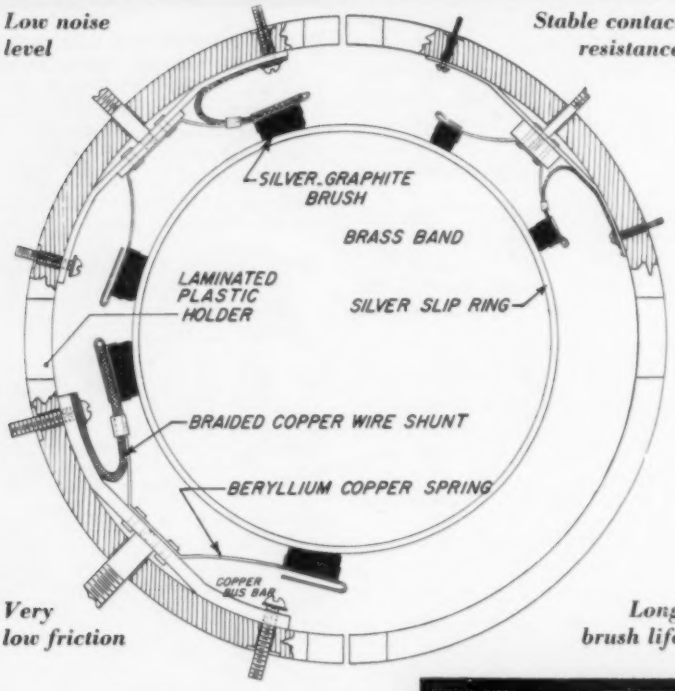

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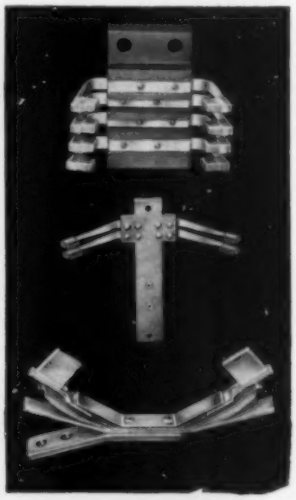

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tions of drive dimensions. Worthington Corp., Harrison, N. J.
Circle 152, inside back cover

Nickel Alloy Tubing—Catalog, 12 pp, describes cold drawn mechanical, capillary, hypodermic, nickel and nickel alloy tubing. J. Bishop & Co., Malvern, Pa.
Circle 153, inside back cover

Thermistors—Catalog EMC-1, 12 pp, gives dimensional drawings, physical descriptions and complete electrical specifications for various forms of precision thermistors, including beads, rods, discs, washers, and built-up assemblies. Fenwal Electronics, Inc., Mellon St., Framingham, Mass.
Circle 154, inside back cover

Air and Vacuum Pumps—Catalog 755, 12 pp, describes line of air motors and gas pumps. Leiman Bros., Inc., 164 Christie St., Newark 5, N. J.
Circle 155, inside back cover

Large Diameter Thin-Wall Tubing—Data Memorandum 4, 5 pp, describes tubing in sizes with outer diameters from $\frac{3}{8}$ to $2\frac{1}{2}$ in. and with wall thicknesses of 0.035-in. and less. Superior Tube Co., 1556 Germantown Ave., Norristown, Pa.
Circle 156, inside back cover

Single-Plane Swivel Joints—Catalog sheet 406-A, 2 pp, single-plane joints, in contrast to this manufacturer's self-aligning swivel joints. Barco Mfg. Co., Dept. J-27, 501 N. Hough St., Barrington, Ill.
Circle 157, inside back cover

Anodized Aluminum Strip—Folder, 4 pp, describes continuous coils of anodized and dyed aluminum strip. Fromson Orban Co., Inc., 261 Madison Ave., New York 16, N. Y.
Circle 158, inside back cover

PVC Compounds—Bulletin, 4 pp, deals with use of these compounds in the manufacture of rigid vinyl pipe and fittings. Summarizes typical physical properties determined on specimens representing the two compounds and tabulates a series of characteristic chemical immersion results. B. F. Goodrich Chemical Co., 446 Rose Bldg., Cleveland 15, Ohio.
Circle 159, inside back cover

Solenoid Valves—Catalog 201, 32 pp, contains engineering information, flow
(Continued on page 355)

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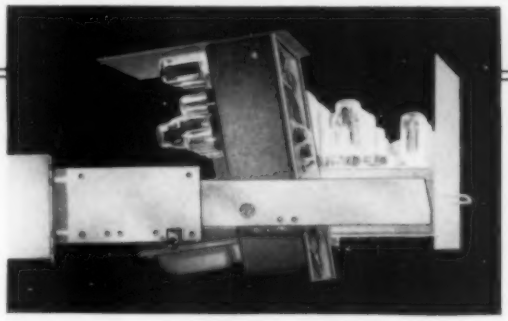

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charts, operation and construction details, illustrations, prices. Automatic Switch Co., 391 Lakeside Ave., Orange, N. J.

Circle 160, inside back cover

Rotary Cam Limit Switch—Bulletin 1600 B, 8 pp, describes limit switch for mechanical presses. Danly Machine Specialties, Inc., 2100 S. Laramie Ave., Chicago 50, Ill.

Circle 161, inside back cover

Hydraulic Oil Coolers—Bulletin 55-69, 8 pp, describes air and water type coolers for industrial hydraulic systems. Vickers Inc., Box 302, Detroit 32, Mich.

Circle 162, inside back cover

Cast Irons—Folder, 4 pp, covers commonly used specifications of gray and nodular (ductile) cast irons. Specifications for cast pressure pipe, soil pipe, valves, and fittings are also summarized. Gray Iron Founders' Society, Inc., 930 National City-E. Sixth Bldg., Cleveland 14, Ohio.

Circle 163, inside back cover

Directional Control Valves—Bulletin 80300, 16 pp, includes details of valve body construction and functions of standard and special plungers. Oilgear Co., 1578C W. Pierce St., Milwaukee 4, Wis.

Circle 164, inside back cover

Shock and Vibration Mounts—Bulletin 56-02, 7 pp, provides design procedure for application of shock and vibration mounts to protect shipboard and vehicular equipment. Includes complete performance data and characteristic curves for obtaining proper system natural frequency to protect equipment. Barry Controls Inc., 830 Pleasant St., Watertown 72, Mass.

Circle 165, inside back cover

Single-Phase Motors—Bulletin 470-A, 4 pp, describes 10 and 15 hp all-weather high torque, capacitor-start, capacitor-run, single phase motors. Robbins & Myers, Inc., Springfield, Ohio.

Circle 166, inside back cover

Plastic Products—Brochure, 8 pp, gives information on chemical, electrical and mechanical properties of Teflon and Raylon, and also provides complete specifications on sizes in which sheets, tape, molded and ex-

(Continued on page 357)

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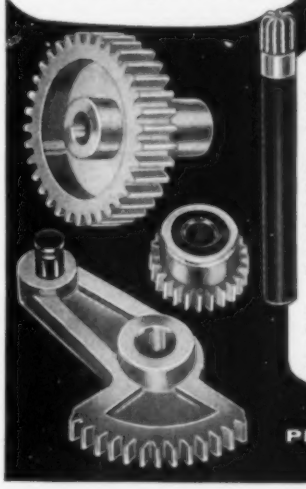

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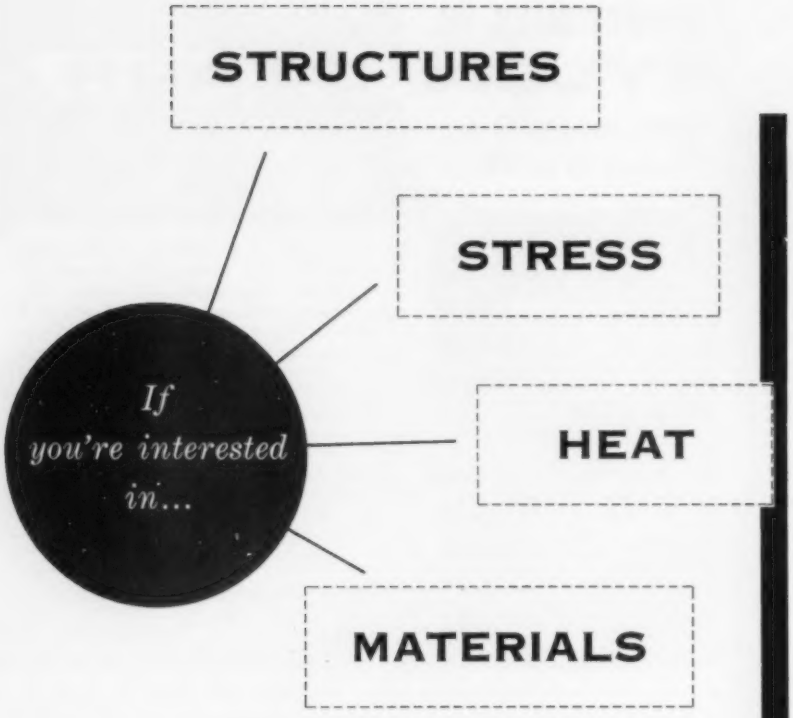

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For the analysis and design of missile structures and other airborne equipment. Also adhesives engineers, metallurgical and materials engineers with aircraft or missile design experience.

MECHANICAL ENGINEERS
To participate in the design and development of missiles, missile launchers, aircraft structure, component installation, environmental test equipment and general mechanical design.

AERONAUTICAL ENGINEERS
For the analysis and design of missile launching equipment for high-speed aircraft, including coordination and liaison with many major airframe manufacturers.

DYNAMICS ENGINEERS
To work on shock and vibration problems in an aerothermal environment. Also elasticians to work on advanced aerothermoelastic problems associated with high-speed flight.

ENGINEER
For research related to the selection of materials and development of fabrication techniques.

LIAISON ENGINEER
To work between Development Laboratories in Culver City and Engineering Laboratory in Tucson or between the Laboratory and subcontractors.

THERMODYNAMICIST
To perform analytical and experimental analysis of heat transfer from electronic components via natural convection, forced-air convection, and radiation.

These positions also available in the Research and Development activity at Tucson, Arizona.

truded rods and tubes are available. Raybestos-Manhattan, Inc., Manheim, Pa.

Circle 167, inside back cover

Valve Stem Packing–Bulletin, 4 pp, describes two general types (braided asbestos yarns, and plastic), manner in which they are made, illustrates shapes most commonly used, and lists size limitations. Raybestos-Manhattan, Inc., Passaic, N. J.

Circle 168, inside back cover

Gearmotors–Bulletin 1880, 16 pp, shows comparative advantages of gearmotors, lists ratings from ¼ to 30 hp, with gear ratios as high as 10:1. U.S. Electrical Motors, Inc., P.O. Box 2058, Los Angeles 54, Calif.

Circle 169, inside back cover

Automatic Clutches–Bulletin 56-D-1, 4 pp, has illustrations and descriptions covering a variety of automatic clutches and transmissions. Salsbury Corp., 1161 E. Florence Ave., Los Angeles 1, Calif.

Circle 170, inside back cover

Whiteprinting Machine–Folder, 8 pp, gives details of construction, operating features, dimensions, other data on whiteprinter of 42-in. width capacity. C. F. Pease Co., 2601 W. Irving Park Road, Chicago 18, Ill.

Circle 171, inside back cover

Letterhead Requests Only

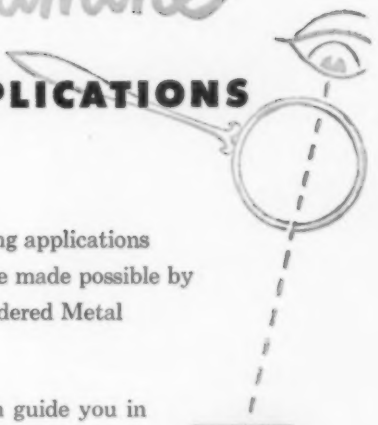
Manufacturers who published following literature ask that requests for copies be made on company letterheads.

Standard and Simplified Drafting–Booklet, 56 pp, contains a speech on this subject as given before the American Society for Engineering Education. The remaining 44 pp are devoted to details of this company's standards on drafting room practice and simplified drafting. American Machine & Foundry Co., 261 Madison Avenue, New York 16, N. Y.

Electrical, Electronic Hardware–Catalog S-57, 28 pp, contains specifications, drawings, schematic circuits and prices on jacks, plugs, switches, connectors, shielded jacks, cable assemblies, jack covers, adapters, jack strips Switchcraft, Inc., 1328 N. Halsted Street, Chicago 22, Ill.

time to re-examine

BEARING APPLICATIONS



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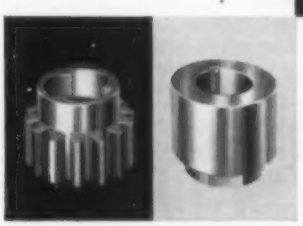
A competent group of Bunting Sales Engineers in the field and a soundly established Product Engineering Department put at your command comprehensive data and facts based on wide experience in the designing and use of cast bronze and Sintered Powdered Metal Bearings and parts.

Write to our Product Engineering Department in Toledo or consult our nearest Sales Engineer.



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HOLTZER -CABOT

R-24 Motor

Synchronous and Induction Capacitor Type Motors

R-25 Motor

R-24. Typical applications for this reversible, 4-pole induction motor are in servo mechanisms, as a balancing motor in recording instruments or as a control motor for voltage regulators. It has low rotor inertia for fast response applications. When operated 2 phase, it can be controlled electronically; or operated single phase as a permanent split capacitor motor.

R-25. Typical uses are for recording instruments, dictating and adding machines. Approximately 2½" in diameter, it is available in either induction or synchronous construction with reversible rotation.

Both the R-24 and R-25 are available with gear case speeds from 1/2 to 3600 RPM, torque ratings up to 75 oz. inches or higher, and single phase, 2 or 3 phase.

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HOLTZER-CABOT MOTOR DIVISION
NATIONAL PNEUMATIC CO., INC.
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GENTLEMEN: Please send me data sheets on the Holtzer-Cabot R-24 and R-25 Size Motors.

Please have representative call _____ (date)

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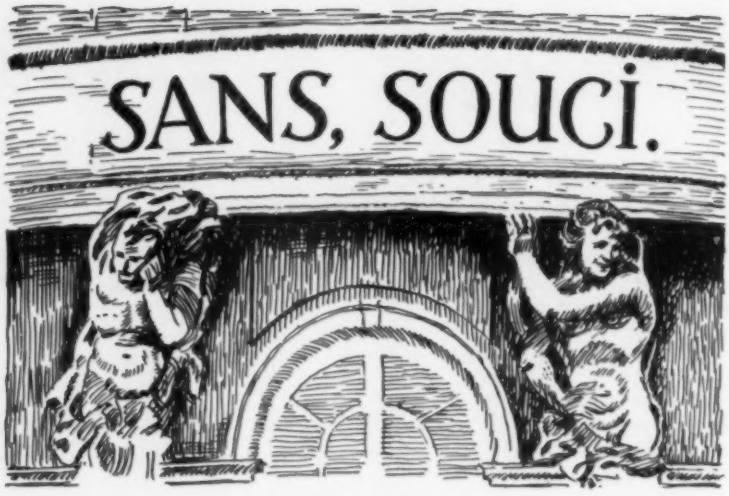
Company _____

Street _____

City _____ Zone ____ State _____



Ad Libbing by the Editor

Loose talk says that researchers and engineers are introverts, timid, not sales minded, and lots of other negatives. Of course any person with a balanced mind knows that sweeping statements of this kind are never true. Usually the exceptions to the rules outnumber the adherents when it comes to applying a generalization to a whole group, class, creed, race or nationality.

When it comes to salesmanship, I know of two instances in which learned research workers demonstrated a degree of sales acumen that is not commonly found even among salesmen themselves. The one instance was a beautiful example of "silent salesmanship." This is not common because salesmen, in general, like to talk and practically all courses in salesmanship revolve around training in how to talk, how to hold the audience, and how to sway the prospect with promises, descriptions and the veiled threat that he will miss much and be considered of low estate by his neighbors if he fails to buy the swimming pool, lawn chairs, bar for the recreation room, or whatever it may be.

Now no one can doubt that such sales courses do train a man to sell his wares to the broad consumer market. "Foot-in-the-door" tactics and "keeping up with the Joneses" appeal, however, do not often sway management to accept, produce and sell some newly developed "laboratory" products. And once in a while you do discover an engineer who is smart enough to know it.

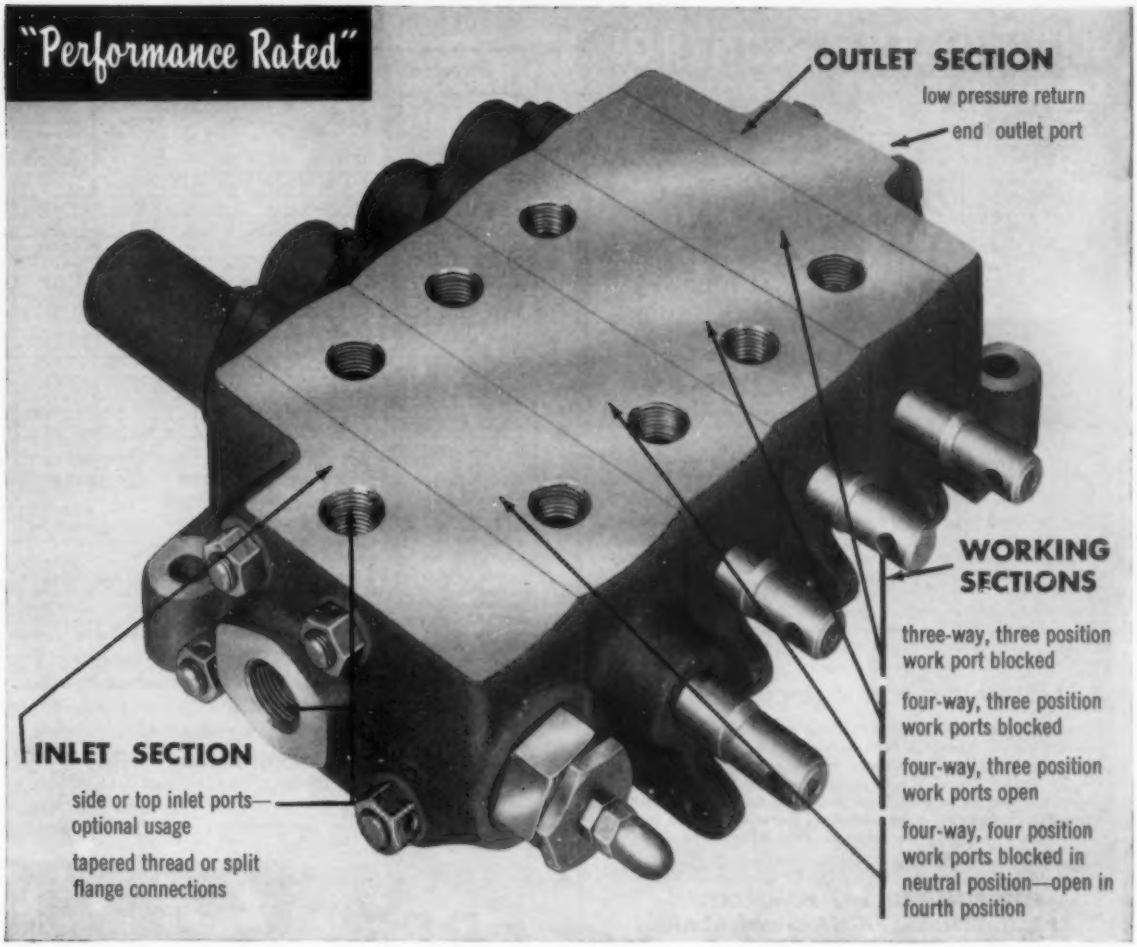
It was quite a few years ago when I heard this story from one of the veeps of Du Pont. As he told it, the chemists in research had devoloped a new kind of insect spray that possessed amazing qualities. Merely a light spraying in a room or hall would kill all the flies, mosquitoes and whatever other insects were there. Humans would not be affected by the spray. The chemists called it DDT because its full name was unfortunately all but unpronounceable.

At that time a spray of such power had been unheard of. When the researchers talked about it to the sales executives, the latter raised their eyebrows and coldly remarked, "How nice!" It was evidently going to be hard sledding to convince management that a few hundred thousand dollars should be invested to set up for the manufacture of this stuff, and a few hundred thousand more to get it on the market.

After much maneuvering the chemists were able to get a meeting arranged at which sales managers, advertising managers and a good representation of top management would give the chemists an opportunity to convince them that DDT was really a product with a promising future. The three chemists held a meeting in advance to plan their presentation.

The main meeting was held in a large air-conditioned room. There was much dignity and decorum. Indeed, the atmosphere of a funeral prevailed. The chairman spoke gravely as he explained the purpose of the meeting.

(Continued on page 361)


"Performance Rated"
OUTLET SECTION
low pressure return
end outlet port
WORKING SECTIONS
three-way, three position work port blocked
four-way, three position work ports blocked
four-way, three position work ports open
four-way, four position work ports blocked in neutral position—open in fourth position
INLET SECTION
side or top inlet ports—optional usage
tapered thread or split flange connections

NEW DIRECTIONAL CONTROL VALVES DO THINKING FOR CYLINDERS AND MOTORS

Every working section of these new valves has its individual built-in check which blocks against all return flow until the return pressure is overcome by pressure build up from the pump. This means that irrespective of the number of working sections which may be in operating position no load drop can occur. Danger resulting from erratic operation or one load dropping while another is being positioned is eliminated. Not even the slightest pre-lift drop can occur as a load is being positioned.

Other important new features have been incorporated in these new valves which reduce their internal pressure loss. Internal passageways are larger, of more uniform cross section, free from abrupt change of direction and have smoother wall surfaces. Spools are solid and without internal restriction. Thus constriction to flow inside these valves is less than other valves and their pressure drop has been improved as much as 15%. All sealing between sections and at ends of spools is by O-rings instead of gaskets, so now you can use these valves at working pressures up to 2000 psi and have trouble free, leak proof operation with the timing action so exact and precise that "inching" loads to exact position is a stable operation.

Safety protection for the hydraulic system, plus overload protection for the structural members and tools of the machine in operation, are provided by a new combination overload relief-pressure control valve. It is built into a complete cartridge and is easily removed as a unit from the inlet section of the valve bank. Thus inspection of this important sentinel is easy and replacement can be accomplished in a matter of minutes.

Available in three sizes, you will find these new "B" series valves have higher performance ratings than other valves. To assist you in selecting the size best suited for your application, data is available to show their internal pressure drop for different volumes of flow under varying operating pressures as encountered in actual operation.

Write to Dept. G-31, The Commercial Shearing and Stamping Company, Youngstown, Ohio; Chicago, Illinois; Salt Lake City, Utah.

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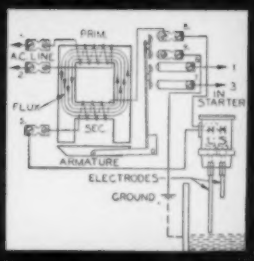
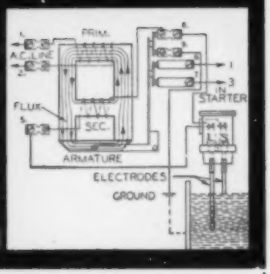
LIQUID LEVEL CONTROL
with the
B/W RELAY





Type LH Relay
for
Pump Down Control

POSITIVE AND DEPENDABLE

The B/W system of liquid level control consists of a transformer type induction relay and a holder for one or two electrodes, depending on the desired operation and the type of relay used. The relay incorporates a primary or line voltage coil connected to a permanent source of alternating current, and a secondary or electrode circuit coil connected to the electrodes immersed in the liquid being controlled. Energizing the primary coil causes an induced voltage in the secondary coil; thus the secondary coil is never connected to the power line.

LIQUID IS ELECTRICAL CONDUCTOR

The liquid itself is the electrical conductor that completes the secondary circuit. When this secondary circuit is completed, by the liquid contacting both electrodes, the magnetic attraction set up in the legs of the relay core causes the armature to close, and open or close the load contacts. A built-in holding circuit maintains this contact until a predetermined fall in liquid level breaks the circuit. By adjusting the electrode settings, the range of operation can be controlled.

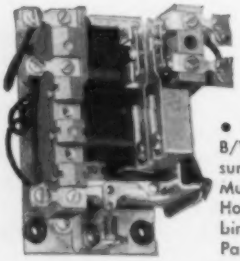
FOR PUMP UP and PUMP DOWN APPLICATIONS, SIGNALS and ALARMS

B/W relays are designed for either pump up or pump down operation. In addition, by using a single electrode they are well suited for signal and alarm applications.

NO MOVING PARTS

The complete absence of moving parts in the liquid insures long and trouble-free performance. Because of the very low current in the secondary circuit these relays are ideal for many switching jobs outside of the liquid level field.

Consult our engineering department on any special control applications.



CATALOG on request

- It covers the complete line of B/W Induction Relays, Enclosures, Contactors and Starters, Multiple Pump Controls, Electrode Holders, Starter and Relay Combinations, Special Controls and Panels.

B/W CONTROLLER CORPORATION
2218 E. Maple Road, Birmingham, Mich.

FIRST IN THE FLOATLESS CONTROL FIELD

Light metals design tips

Physical Properties of Magnesium Alloys

Alloy & Condition	Sp. Gr. (75°F.)	Density lb/cu. in.	Melting Point °F.	Thermal Conductivity C. G. S. Units (212-570°F.)	Electrical Resistivity microhm-centimeters (68°F.)
A-F	1.80	0.065	1125	0.18	–
C-F	1.82	0.066	1110	0.16	16.0
FS, FS1 & FS1W	1.77	0.064	1160	0.23	10.0
G-F	1.81	0.066	1100	0.17	15.0
H-F	1.83	0.067	1135	0.18	11.5
J1	1.80	0.065	1145	0.19	12.5
O1	1.80	0.065	1130	0.18	14.5
R-F	1.81	0.066	1120	0.13	17.0
AZ81A-T4	1.80	0.066	1114	0.12	15.7
AZ91C-F	1.81	0.066	1120	0.17	17.0
EK30A-T6	1.79	0.065	–	0.25	6.9
EK41A-T5	1.81	0.066	–	0.25	6.6
EK41A-T6	1.81	0.066	–	0.23	7.3
EZ33A-T5	1.82	0.067	–	0.24	7.1
ZK60A-T5	1.83	0.066	1175	0.29	5.7

THE ABOVE TABLE points out certain physical properties of magnesium alloys which often dictate the choice of magnesium for particular product applications.

We have found, for example, that while the thermal conductivity of magnesium alloy is rather stable, the coefficient of thermal expansion is approximately 0.0000145 per degree Fahrenheit within the temperature range of from 70 to 212° F. This physical property would have an especially important bearing on designing magnesium assemblies that are to be rigidly connected to other metals.

Consideration of mechanical, physical and chemical properties of magnesium are fully described in Magcoa's Magnesium Design Handbook. Write today for your free copy.

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LIGHT METALS FABRICATION DIVISION • EAST CHICAGO 27, IND.
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Dept. P-8 712 E. 163rd St., Cleveland 10, Ohio

A fly buzzed around his face. In a few minutes there were more flies buzzing around more faces. Finally there were many exclamations and cuss words when the flies had finally "taken over the meeting."

Then the head of the delegation of chemists arose. "Gentlemen, if you look under the table you will see a large fly trap almost half full of flies. It was full when we put it there and opened the gate to let them out. Here in my hand I have any ordinary cheap sprayer that can be bought in the five-and-ten. It is loaded with DDT. Now with a few strokes of the plunger we will spray a light mist into the air in this room. See the result. That fly that just dropped on the table is groggy. There go two more. Look on the floor and you will see a number of dead ones."

In a few minutes there were no more live flies in the room. The meeting adjourned shortly afterward. DDT was soon on the market, a howling success. A sales argument without words had put it across. And that is the finest kind of sales talk because one cannot dispute or argue against silence.

A similar "sales talk" was used in inducing General Motors to use Duco for the finish on their automobiles. "Boss" Kettering and a number of other General Motors executives met with DuPont officials. Just before lunch, one of the Du Pont men started a discussion about colors with one of the G.M. men who had driven to the meeting in his car. The G.M. man said his car was gray but he really preferred blue. After lunch this G.M. man was given his car which had been refinished in a beautiful blue, with Duco of course. The speed of the operation and the quality of the job convinced the General Motors men that here was the answer to the problem of automobile finishing.

Accidental Assistance

My third example of silent salesmanship relates to an accident. Many years ago I referred to it in an editorial. "Mack," I have forgotten his full name, was the star salesman for Electric Service Manufacturing Company of Philadelphia. It was in the early twenties and the company was trying to get the railroads to buy locomotive headlights with glass reflectors.

(Continued on page 362)

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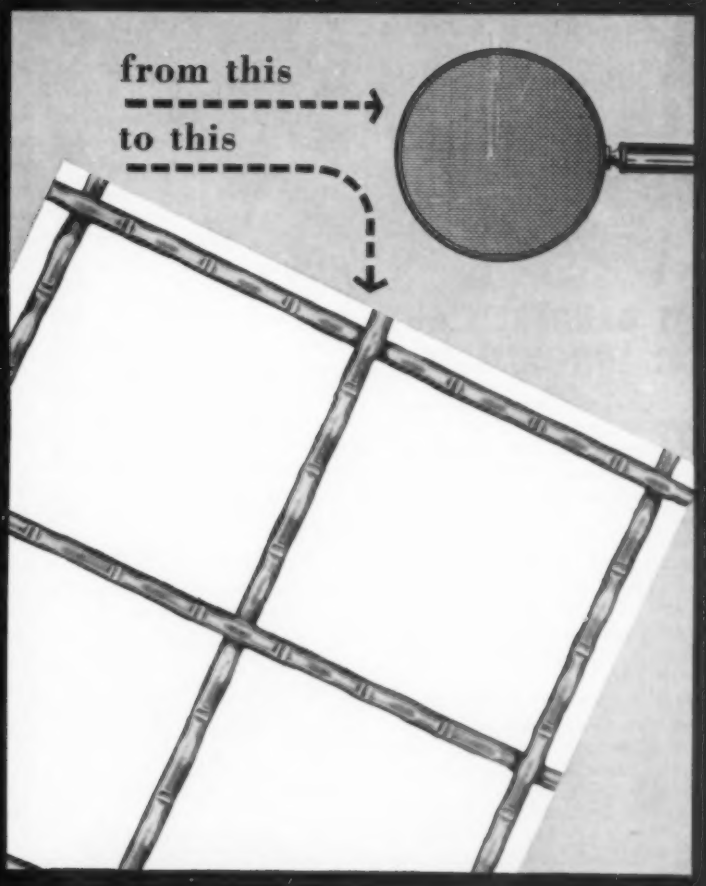

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I'M A TOUGH BUYER

BUT GARRETT'S GOT IT FOR QUALITY

No sir, *you can't beat Garrett* when it comes to top quality in small parts. Their "statistical quality control system" means every shipment you get is the finest. But quality is only part of what I like about Garrett. They manufacture and stock the world's most complete line of washers and hose clamps. Boy, when you need any kind of a lock washer, flat washer, spring washer or hose clamp you get it fast . . . most everything right out of stock.

When it comes to stampings and assemblies that's where their high-speed automatic equipment stars. Turns out exactly what you want in no time at all.

Sure, I'm a tough buyer. I want the best. I want it fast. I want it priced right. And Garrett is the place for me.

LOCK WASHERS
FLAT WASHERS
HOSE CLAMPS
STAMPINGS

Manufactured by

GEORGE K. GARRETT CO., Inc.
Philadelphia 34, Pa.

Garrett
OF PHILADELPHIA

Sans, Souci . . . . . continued

They had sold a few to some of the small roads and then sent Mack to crack the biggest of them all, the Pennsylvania Railroad.

If such a sale could be made, the prospects for lining up business with the smaller roads certainly would be bright and rosy.

Mack went to the railroad offices in Philadelphia to meet with the Pennsy's purchasing agent, superintendent of motive power, a couple of roundhouse superintendents and a few others. Mack had with him a sample headlight.

Nothing that Mack said or did succeeded in raising anything other than sales resistance. The railroad men claimed the glass parabolic reflector would crack from vibrations from the locomotive. Mack took out the beautiful glass reflector and showed how it was mounted on a felt lined ring that was held entirely by suspension springs. That was greeted with a grunt and the comment, "Sure, it's O.K. for a fellow like you working on this nice clean table top, to take out, and replace the reflector. But in a roundhouse the mechanics are rough. They would drop the reflector down on the bench and that would be the end of it."

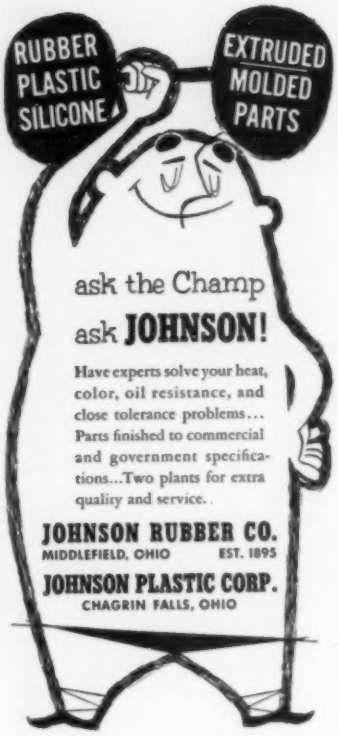
Mack argued, explained and told how the Boston and Albany had had no trouble of that kind. He did not say the Boston and Albany had only one such headlight on trial, and had had it only a week. But anyhow, it was "no sale" and dejectedly, and perhaps a little irritably, Mack started to reassemble the lamp. Half way through the job of fitting together the pieces of the sample headlight, the unexpected happened.

Mack's elbow bumped the glass reflector lying on the table. The reflector dropped to the floor, bounced once or twice, and came to rest without having been damaged in any way. Mack was quick. He merely said in a somewhat casual manner, "Gentlemen, there is the real answer. You have seen with your own eyes that these glass reflectors are not fragile. Indeed, we might almost say they are unbreakable."

Mack got a nice order. As he said later, "I still can't figure out why that reflector didn't at least crack."

Here again, not words but action clinched the sale.

–G.F.N.



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FORT WAYNE, INDIANA

ABSTRACTS

Load-Carrying Capacity Of Spur-Gear Teeth Hob Cut From Molded du Pont "Zytel" 101

Abstracted from "Load-Carrying Capacity of Spur-Gear Teeth Hob Cut From Molded du Pont 'Zytel' 101," by K. W. Hall, Assoc. Prof. of Mech. Engrg., and H. H. Alvord, Asst. Prof. of Mech. Engrg., University of Michigan, 331 W. Engrg. Bldg., Ann Arbor, Mich.; presented at the ASME Semi-Annual Mtg., June 17-21, 1956, Cleveland, Ohio.

Method of calculating the load-carrying capacity of spur-gear teeth hob cut from molded du Pont "Zytel" 101 is based on results obtained by testing 72 gears. Breaking strength rather than tooth wear governs the load-carrying capacity of these teeth. However, wear rates of the teeth, with and without lubrication, are also presented.

Qualities of nonmetalic gears often include quietness of operation, ability to absorb shock loads, resistance to corrosion, and ability to operate with various fluids used as lubricants. "Zytel" is a nylon resin that is thermoplastic and supplied in the form of a granulated powder from which various products can be molded by coventional molding techniques. It is made in several varieties, of which "Zytel" 101 is the most heat resistant and best suited for mechanical parts. In the molded form it is easily machined. Typical physical properties are:

Tensile strength, 70 F, psi	9300
Elongation, 70 F, per cent	220
Modulus of elasticity, 73 F, psi	200,000
Shear strength, psi	8000
Impact strength, Izod, 73 F, ft-lb/in.	2.0
Hardness, Rockwell	R108
Specific gravity	1.14

Maximum total composite error was 0.0013 in. for all gears taken together, while maximum tooth-to-tooth composite error was 0.0006 in. Bending stress in teeth was calculated by the basic Lewis equation rewritten as:

$$S = 2TP/Dfy$$

(Continued on page 365)

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FLUID METERING PUMPS

Positive Displacement Rotor Type. For Industrial Applications, Aircraft Anti-Icing and Aircraft Fuel.

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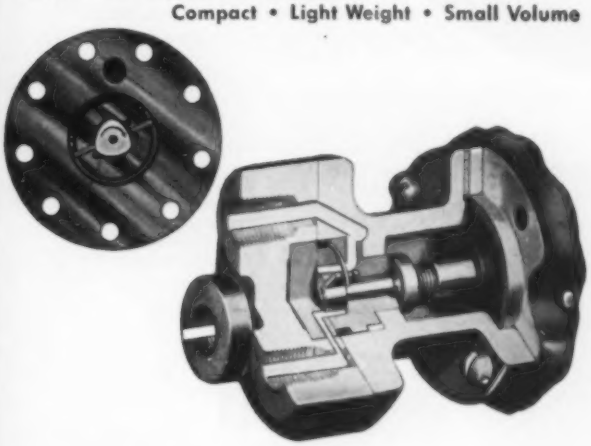
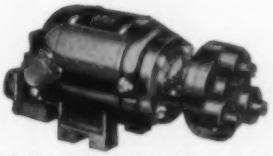
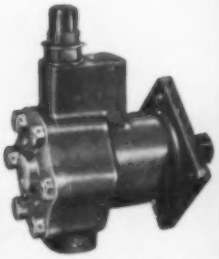


IT'S SO SIMPLE!

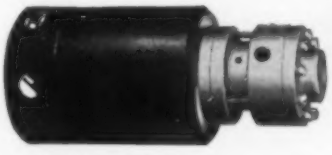
The rotation of the rotor draws the fluid in through two passages, filling the cavities formed by the three lobes of the rotor. This fluid is sealed within these small cavities until it is forced through the two outlet holes by the floating blades. The flow may be kept uniformly divided through two outlet ports, or may be combined internally for passage through a single port.



STYLE A—Single inlet double outlet type aircraft pump



STYLE F—Engine driven fuel pump



STYLE C—Industrial pump

Send for Weldon Manual and Catalog with detailed specifications and installation drawings.

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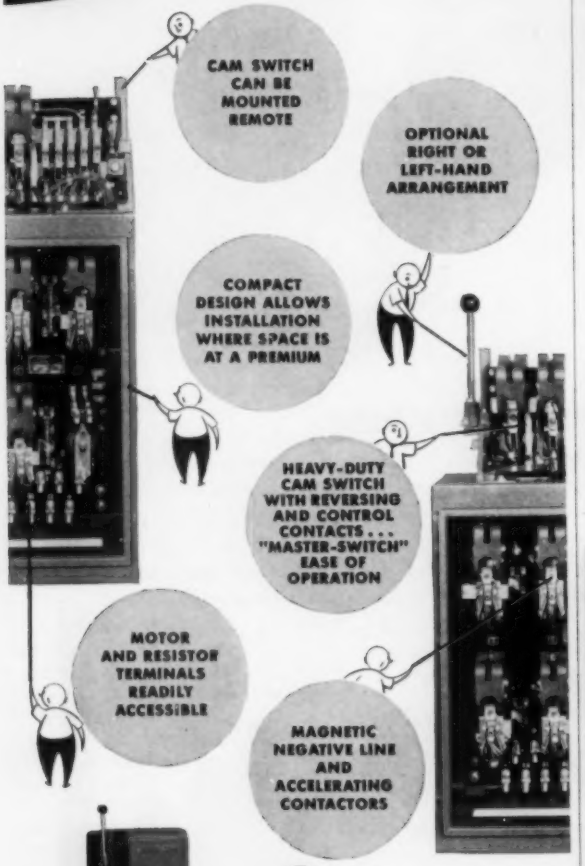
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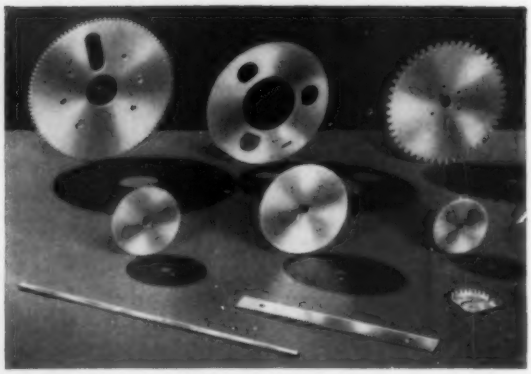

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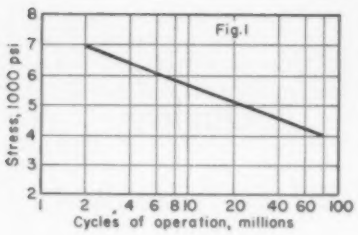
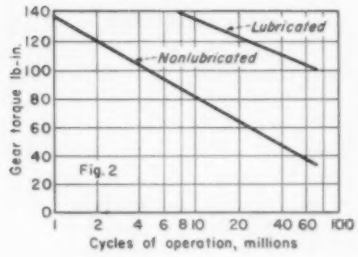




where S = bending stress at root of teeth, P = diametral pitch, T = torque on gear, lb-in., D = pitch dia, f = face width, in., y = tooth form factor.

The equation assumes that one tooth carries all the load. Photographs taken under static load in various positions of engagement showed that this condition exists.

Results of tests showed that for lubricated teeth, load-carrying capacity is governed by the breaking strength of the teeth—not by teeth wear. This is also true for non-lubricated teeth, although tooth life prior to breaking is considerably reduced. When teeth are cleaned with a solvent, load-carrying capacity is greatly reduced and is governed by tooth wear.

The chart in Fig. 2 is based on test results. Note that the failure stress continues to decrease with the number of cycles indicating no definite flexural endurance limit for this material or stress below which the teeth can operate indefinitely without failure. Allowable or working stress should be about 75 per cent of the failure stress.

When teeth are not lubricated after being doused initially with oil, failure takes place just below pitch circle rather than at root of tooth. Continued operation after a tooth has broken tends to mutilate the adjoining teeth. A comparison of the torque capacity of the same teeth, with and without lubrication, is shown in Fig. 2. For

(Continued on page 366)

MARVEL Synclinal FILTERS

For Efficient Filtration of - -

Hydraulic Oils

Fire Resistant Hydraulic Fluids

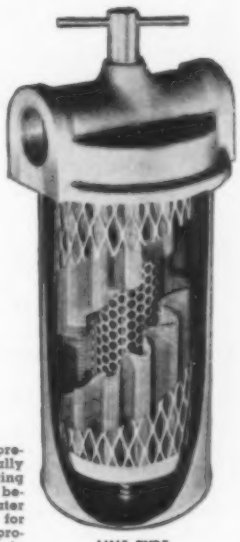
Coolants — Lubricants

Water

SUMP TYPE
(cutaway)

OVER 650
Original Equipment Manufacturers Install Marvel Synclinal Filters as Standard Equipment

Meet
J. I. C. Standards



LINE TYPE
(cutaway)

PROTEST EQUIPMENT—
INCREASE PRODUCTION—
REDUCE MAINTENANCE—

Marvel Synclinal Filters installed in the sump or on the line preceding pump offer maximum protection on all hydraulically actuated and other equipment utilizing low pressure circulating oil systems. Maintenance and production costs are reduced because Marvel Synclinal Filters BALANCED design offers greater ACTIVE filtering area with sufficient storage capacity for filtered out damaging particles, thus longer periods of productive operation are attained at minimum "down time" due to maintenance and repairs.

PRODUCTION ENGINEERS and MAINTENANCE MEN whose job it is to keep production machinery operating at peak efficiency and who have recognized the superiority of Marvel Synclinal Filters in the filtration of hydraulic oils, fire resistant hydraulic fluids, coolants, lubricants, etc. are specifying Marvel Synclinal Filters on all new equipment and standardizing with Marvel Synclinal Filters on all machines within their plants.
Another outstanding reason for their preference is the simple construction of Marvel Synclinal Filters which allows them to be easily disassembled, thoroughly cleaned and reassembled on the spot, by any workman within a matter of minutes. Line type operates in any position and may be serviced without disturbing pipe connections.

A SIZE FOR EVERY NEED

Available for sump or line installation in capacities from 5 to 100 G.P.M. Greater capacities may be attained by multiple installations (as described in catalog). Choice of Monel mesh sizes range from coarse 30 to fine 200.

Catalogs containing complete data available on request

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As in the past Marvel continues to offer Immediate Delivery!

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PE-8

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☐ Catalog No. 107—For Hydraulic Oils, Coolants and Lubricants

☐ Catalog No. 301—For WATER

Data on Filters for Fire-resistant fluids—
☐ AQUEOUS ☐ SYNTHETIC

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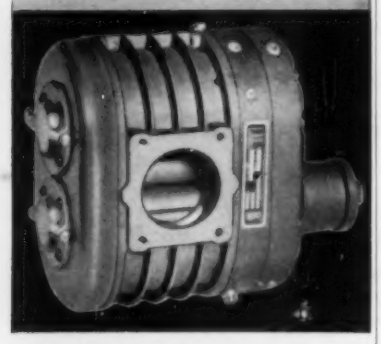
How Miehle-Dexter Blowers supply air for your product



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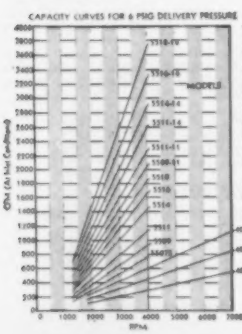

Typical capacity curve for 6 psig. delivery pressure. Standard sizes available up to 4000 cfm. Vacuum to 15" hg. Pressures up to 14 psig. (90 psig. by multi-staging.)

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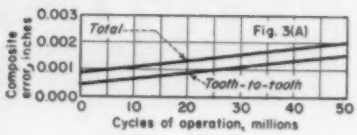
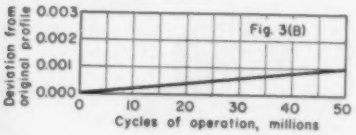
Supercharger Division
Dexter Folder Company
116 Fourth St., Racine, Wisconsin

Abstracts ..... continued





any desired life, the torque capacity is considerably reduced when no lubrication is provided.

Gear Tooth Wear—When lubricated, teeth wore at same rate regardless of load, provided the tooth load was not so large as to cause bending-fatigue failure prior to about 50 million cycles. Fig. 3 (A) and (B) shows the rate of tooth wear as measured by the change in composite error and the profile change. Since the test gears were open to the atmosphere during all the test work, it was concluded that tooth wear might be reduced or elimianted if teeth were totally enclosed to keep out all foreign particles. Another test showed that without lubrication the rate of wear increased with an increase in tooth load.

Materials for Casting Subject to Abrasion And Corrosion

Abstracted from "Fontes, aciers et alliages divers pour moulage de pieèces devant résister à l'abrasion, à la corrosion, ou satisfaire à certaines caractéristiques" by R. Poirot, *La Huille Blanche* (France), Nov. 1955.

Hardness of a given material is not a sufficient indication of its ability to resist abrasion. Identical hardnesses may be accompanied by totally different metallographic structures, while on the other hand a very hard material may not be suitable because of brittleness.

When the abrasive condition is relatively light, experience indicates that pearlitic nodular iron castings give best results. If the abrasion condition is severe, and:

1. If the parts must be machined and are not subject to impact loads, martensitic gray iron containing 4 to 10 per cent Ni is recommended;

(Continued on page 367)

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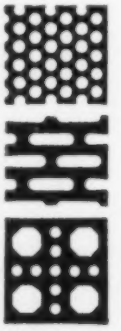

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West Coast Plant
DIAMOND PERFORATED METALS CO.
17915 S. Figueroa St., Gardena, Cal.

2. If the parts do not need machining and are not subject to high impact loading, martensitic white cast irons of the Ni-Hard type are indicated;

3. If the parts are of intricate shape and require a hard core as well as high strength, air hardening nickel-chrome steel or similar alloys are required.

For corrosion resistant castings materials generally used include austenitic Ni-Resist types, the 18-8 class of stainless steels, the cupro-nickels and the nickel-aluminum bronzes.

Ni-Resist materials come in several composition limits, each with a special field of application. Properties and uses are tabulated. They have the advantage of being fairly easy to cast.

Austenitic stainless steels of the 18-8 type are more difficult to cast, due especially to their high shrinkage characteristics; but a number of methods for improving their castability are known.

High nickel alloys of the Monel type have a relatively soft and tough matrix which carries minutely dispersed very hard intermetallic compounds. Additions of tin and silicon multiply the number of the dispersed intermetalics without affecting the properties of the matrix.

The Hastelloys have good resistance to hydrochloric and sulphuric acids in various concentrations. Hastelloy C has, in addition, good resistance to chlorine even in the presence of humidity.

Nickel aluminum bronzes have good heat, wear and corrosion resistance. In addition, they exhibit good resistance to cavitation, erosion and stress-corrosion.

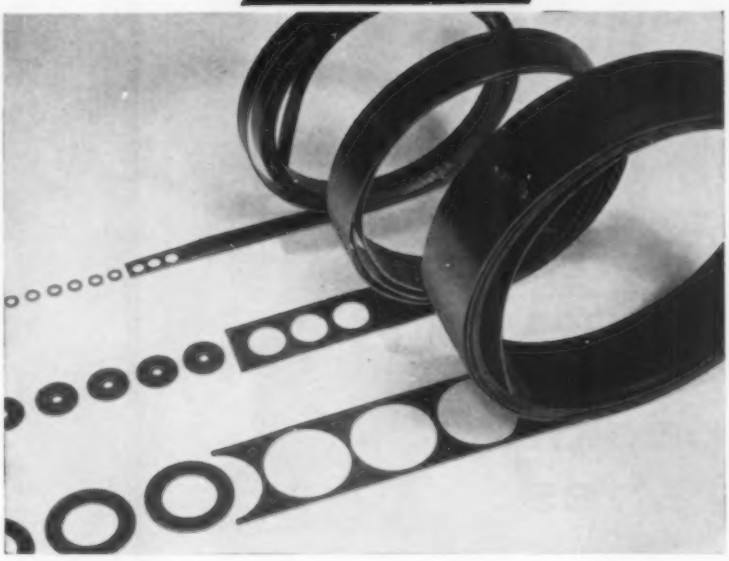
Stress-Corrosion of 18-8

Abstracted from "The Stress-Corrosion Cracking of Austenitic Stainless Steels. Part I—Mechanism of the Process in Hot Magnesium Chloride Solutions" by T. P. Hoar and J. G. Hines, *Journal of the Iron and Steel Institute* (England), Feb. 1956.

Cracking of 18-8 in hot aqueous magnesium chloride solutions occurs in two stages, the first being a pure corrosion stage in which the presence and quantity of applied stress plays an insignificant part. This period is followed by the initiation of cracks on the bared metal surface, and the

(Continued on page 369)

POLYPENCO® NYLON SHAPES



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Provide Smooth Operation Without Lubrication

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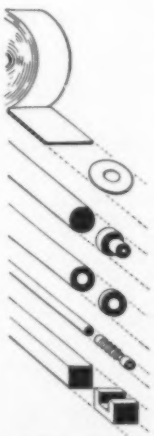

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A molybdenum disulphide filled nylon* formulated to expand the field for nylon. It has a higher heat distortion temperature and lower thermal expansion than standard Nylon 101, combined with a lower coefficient of friction and higher wear resistance in many applications.

HIGHEST QUALITY:

You can expect highest quality nylon with POLYPENCO stock shapes . . . freedom from porosity, uniform properties and maximum dimensional stability.

STOCK SHAPES READILY AVAILABLE:

POLYPENCO Nylon stock shapes are available in rod, strip, tubular bar, tubing and slab. POLYPENCO standard and special nylon formulations are easily machinable on metalworking equipment.

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The 431 Series – a greatly improved version of the Hoke brass bellows needle valve offering extended, leak-tight service life . . . suitable for sampling systems and analysis equipment—bronze bellows, stainless steel (blunt or vee) spindle in $\frac{1}{8}$" and $\frac{1}{4}$" pipe sizes.

The 480 Series – Globe or angle valves in brass or monel with phosphor bronze or monel bellows.

The 440 Series – for supercritical applications An all stainless bellows valve with Teflon seat—$\frac{1}{8}$" to $\frac{1}{2}$" pipe sizes. (Both 480 and 440 series have replaceable bellows assemblies.)

The 411 Series – All metal monel diaphragm valves with low internal volume and excellent service life.

For those of you who have special problems, modifications of these valves are available for high temperatures and pressures. You'll find us most receptive to your inquiries.

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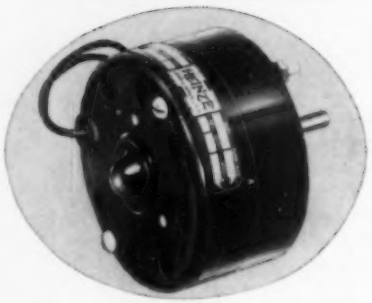

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3¼" diameter. 1/100 to 1/40 HP.
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Free speed, 1700 RPM
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GRIP NUT COMPANY

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propagation of these cracks along planes roughly perpendicular to the line of the applied stress.

Rate of crack propagation is between 0.5 and 3.0 mm/h, being accelerated by increases in temperature, but not affected by stress variations over a wide range. Even after it has begun, cracking can be arrested by cathodic protection. "Cracks are not initiated at the 'stress-raising' corrosion pits, but begin at points on the bared metal surface that are especially anodically active."

The problem of stress-corrosion of 18-8 stainless steels is not likely to be solved by alloy composition changes, nor by heat, mechanical, or surface treatments. Only cathodic protection is effective.

ASTM Symposium on Solder

I—Corrosive Fluxes—Their Role in Soldering, by R. M. MacIntosh.
II—Gray Tin Formation in Soldered Joints Stored at Low Temperature, by W. L. Williams.
III—The Performance of Some Soft Solders at Elevated Temperatures and Pressures, by H. E. Pattee and R. M. Evans.
IV—Ultrasonic Soldering of Aluminum, by J. B. Jones and J. G. Thomas.

These papers were presented at the 1956 ASTM Symposium on Solder in Atlantic City in June 1956.

I–Good soldering practice is largely dependent on the choice of the flux used. Fluxes are classed as highly corrosive, intermediate, and noncorrosive.

Corrosive fluxes have a rapid and positive fluxing action and can be made to penetrate tenacious oxide films, but they leave a chemically active residue which may cause corrosion. Intermediate fluxes decompose easily on heating and are active for a limited time, but they are composed mainly of organic acids which char, burn, or volatilize at high temperature, restricting the use of these fluxes to quick spot soldering operations. Noncorrosive fluxes are not covered.

Typical compositions of corrosive fluxes are given, as well as special soldering practices, particularly of cast iron and aluminum.

II–Brittleness can result in soldered joints at low temperatures from the characteristic behavior of white tin as well as from the formation of gray

(Continued on page 370)

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WAS THE "IMPOSSIBLE" FLANGE!

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They had just designed the first all-stainless-steel cream separator. It involved a flange forming problem, however.

The Milk Supply Tank, largest single part of the Separator, measuring 23¾" x 13½" x 5⅞" deep, has an in-formed flange — notoriously hard to curl smoothly. Now you may think of a separate splash guard welded on, but this offers a cranny custom built for bacteria. If at all possible, the flange had to be integral with the tank. Could Presteel do it? When flange machine makers said it couldn't be done, we stuck to our speciality, press tooling. We added local annealing, leaving the top soft and the sides too stiff to buckle.

Result? BAM – in one stroke – the flange curving inward as pretty as an ocean ripple! Costs were far below estimates for two-piece construction.

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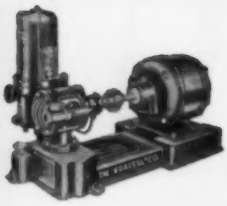

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Air - cooled design — or water - cooled models for heavier duty.

Class 21-roller-action pumps are recommended for handling corrosive gases and extraneous matter that might jam with closer clearances. The multi-blade design of the Class 25 pumps gives higher capacity efficiencies and is designed for applications requiring higher degree of vacuum. Where water - cooling is desired for continuous service, the water-jacketed Class 25-WJ models are recommended.

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tin. Formation of gray tin is influenced by the other metallic elements composing the solder. Rate of transformation is a maximum at −20 to −60 F. High soldering temperature tends to promote transformation.

Seven solders were shear and impact tested at −40 F. The compositions of the solders are given.

III—Eleven soft solders were tested under cyclic loading at 255 F. All solders were tested to failure of a special test joint, and predominant location of failure was recorded. Average and mean number of cycles to failure are given, a 95 Sn, 5 Pb solder being longest lived, with one containing 70 Sn, 30 Pb, 0.25 Ni and one with 70 Sn, 30 Pb, 0.2 Ce being almost as good.

Corrosion of solders by antifreeze solutions was approximately directly proportional to concentration of solution. Increased tin content slowed down the corrosion rate.

IV—Aluminum's high susceptibility to corrosion by fluxes has spurred the development of ultrasonic soldering techniques. These utilize ultrasonically induced cavitation in the molten solder composition to erode the tenacious aluminum oxide film and promote wetting or tinning of the unoxidized metal. Two types of test specimens were used for the evaluation of solders in two corrosion environments.

Photomicrographs of soldered joints show the rate of corrosion in distilled and in salt water for three different soldering alloys.

Stainless Steel for Corrosion Resistant Service

Abstracted from "Stainless Steel for Corrosion Resistant Service", by K. S. Sarma, *Journal of the Institution of Engineers* (India), February 1956.

After exploring the relevant properties of 18/8 stainless steel, the article describes the effect of these on the fabrication and design of welded equipment for corrosive service.

When two pieces of sheet or bar are to be welded, the electrodes must have nearly the same composition as the work so that the resultant joint will be uniform. Stainless steel can be joined by gas or arc welding, provided

(Continued on page 371)

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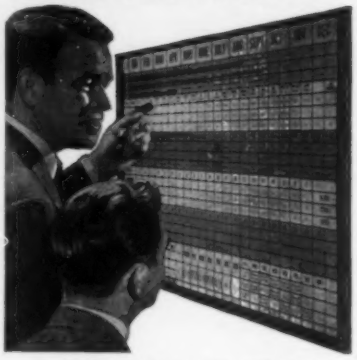

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precautions are taken to prevent carburization, oxidation and overheating. Gas welding is only used on very thin sheets. Arc welding is most generally used, with either coated electrodes or inert gas atmosphere.

The coefficient of expansion of stainless, 1.45 times that of mild steel, causes the parts in and very near the weld to undergo great distortion. This is aggravated by the low thermal conductivity (about one-third of mild steel), which causes portions adjacent to the weld to remain comparatively cool. Several welding methods are listed to overcome this distortion.

Due to the low thermal conductivity of 18/8, the current required for a particular metal thickness is about 20 per cent less than that for a corresponding mild steel.

Exposure of the hot zone to the oxygen of the atmosphere reduces the corrosion resistance of stainless steel at the joint. Coated electrodes or inert gas shield welding prevent atmospheric oxygen from affecting the weld.

Smooth finish increases the corrosion resistance of 18/8.

When stainless steels are welded to mild steel, care should be taken not to dilute the alloying elements in the stainless steels. Electrodes with a higher percentage of the alloying elements overcome this difficulty.

Due to superior mechanical properties, the use of thin sections is possible; but when heavy stress combines with severely corrosive conditions, life of the part is reduced considerably. Economy of design is not directly proportional to maximum stress allowed: temperature changes can set up stresses causing stress corrosion.

Electrolytic corrosion results when stainless steel comes into contact with lead, tin, nickel, etc. Insulation can prevent the formation of an electrolytic cell.

Although stainless steel is highly corrosion resistant in the presence of most chemicals, it is severely attacked by chlorides, even in concentrations as low as 0.5 per cent.

After fabrication of stainless steel equipment is completed, passivation or hastening the formation of an oxide film will give the new equipment better corrosion resistance properties. A number of proprietary solutions are available commercially to induce the formation of the protective oxide on stainless steels at various desired rates.

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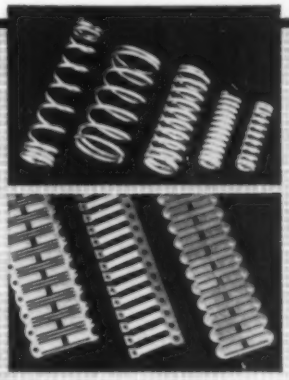

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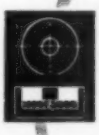

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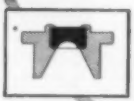

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NEW BOOKS

Proceedings of the World Symposium on Applied Solar Energy

8½ x 11 *in.*, 304 pp. *Published by Stanford Research Institute, Menlo Park, Calif.* $5.

This volume contains 30 papers by internationally recognized authorities on solar energy. Subjects include solar water heaters, solar collector design, solar energy conversion and algal culture studies. An opening 7-page section contains pictorial highlights of symposium sessions and of the Solar Engineering Exhibit, held in conjunction with the symposium. Final section is a summary of the concluding session, a round-table discussion, which dealt with "The Future of Applied Solar Energy."

Industrial Electricity Volume 1, Direct Currents

CHESTER L. DAWES. 9¼ x 6¼ *in.*, 431 *pp. Published by McGraw-Hill Book Co.*, 330 W. 42*nd St., New York* 36, N. Y. $5.50.

This new edition has been revised to make it more suitable for use at the technical institute level. There is an expanded, more detailed treatment of fundamental electric theory, electric circuit theory, electrical measurements, magnetic theory and magnetism, and electrical machinery with its many applications.

Among new topics are the modern theory of magnetism based on the Bohr atom, the spinning-electron domain theory, semiconductors, varistors, thermistors, the Ruben primary cell, Nicad and Sonotone storage batteries, Alnico alloys, analysis of commutation, the amplidyne, automatic motor starters, and the vibrationless Prony brake, along with many other topics of importance.

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(Continued on page 375)

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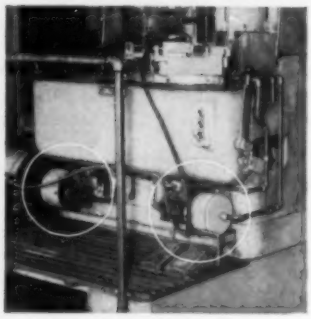

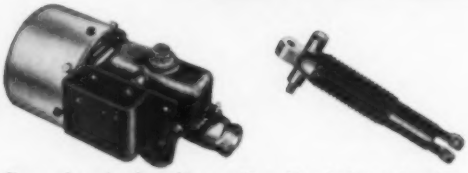

Shown above is a broaching machine with swivel type clamping fixtures, utilizing the Wagner power cluster which converts air pressure to hydraulic pressure that is delivered to actuating cylinders on each of the clamping fixtures.

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Instructors and self-study users will find helpful features such as chapter summaries, a set of 376 problems closely related to the text, diagrams and illustrations which are explained in detail, and many tables.

Refrigeration Manual

8½ x 11 *in.*, 133 *pp, paper-bound. Published by The Trane Co., La Crosse, Wisconsin.* $1.50.

This is a third edition revised to include new information on condenser fouling factors, motors and motor control equipment, mufflers, single and multiple compressor piping arrangements, piping sizes, hanging and insulation. Tables have been added on thermostatic expansion valves.

Explanations and descriptions of selecting installations and servicing of compressors, evaporators, condensers, cooling towers, heat exchangers, controls, refrigerants, and refrigerant piping. A chapter on trouble analysis in table form lists the ten major operation problems, their possible cause identified by symptom and a recommended course of action to correct the fault.

Metallurgical Thermochemistry

O. Kubaschewski *and* E. L. Evans. 8¾ x 5¾, 410 *pp. Published by John Wiley and Sons, 440 Fourth St., New York 16, N. Y.* $10.

The second edition of this monograph by two British scientists is the first printing in the United States. The book was written for both the researcher gathering fundamental data in the laboratory and the process metallurgist applying this data to the solution of practical problems.

Developed in five sections, the first part of the book presents the basic formulas for the application of fundamental data to chemical reactions. New material on non-regular solutions and slag-metal equilibria has been added in this edition. The second part describes the main experimental

(Continued on page 376)

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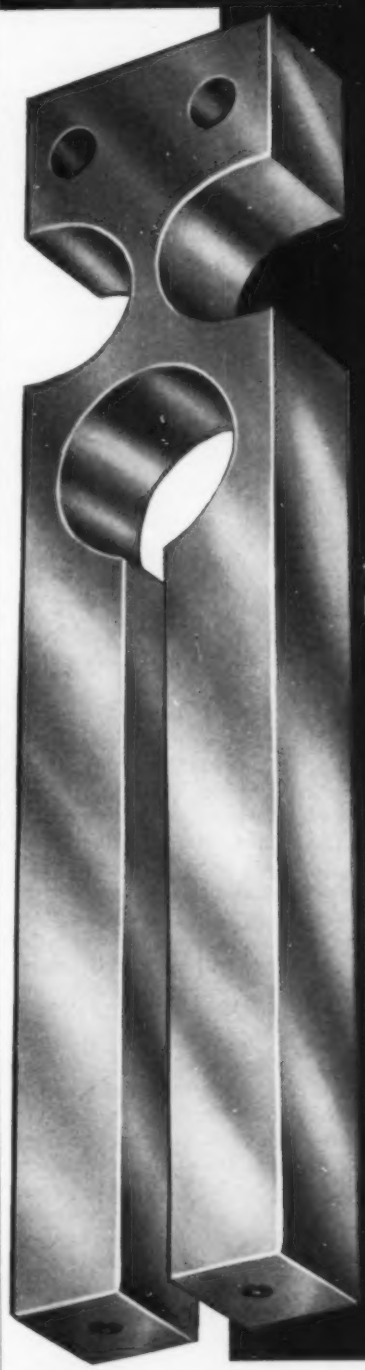

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techniques used to determine thermochemical data. Several new devices are mentioned in the new edition.

In the third part, methods of estimating thermochemical data are discussed. These methods may be used to estimate with reasonable accuracy data which have not been, or cannot be, determined experimentally. The fourth part presents tables of thermochemical constants for a large number of elements and compounds of possible metallurgical importance. These tables have been up-dated in the second edition as a result of recent research both here and abroad.

The last section presents examples of practical applications of thermochemical methods. The book assumes an acquaintance with the elements of chemical thermodynamics.

Strength of Materials, Part II: Advanced Theory and Problems

S. Timoshenko. 6 x 9 *in.*, 572 *pp. Published by D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J.* $7.50.

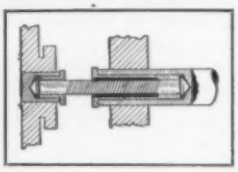
Part II of this standard work on strength of materials, thoroughly revised in this new third edition, features a completely rewritten chapter on mechanical properties of materials. Almost doubled in size, this chapter is virtually a textbook in itself. Professor Timoshenko's familiarity with the experimental work and literature of several countries, including the United States, Russia and Germany, puts him in a unique position to write on this subject.

The chapter includes such topics as the behavior of both brittle and ductile materials, the behavior of individual crystals in a metal, the phenomenon of yielding, fractures of materials, tension and compression tests, tests under combined stresses, strength theories, impact tests and fatigue of metals. Creep is discussed at length, including creep under combined stresses. The chapter concludes with a discussion of how the engineer should select working stresses on the basis of our knowledge of the mechanical properties of materials.

Other features of this revision are: new material on the buckling of

(Continued on page 377)

WHY COUPLING



Coupling is used for the transmission of power or control of movement between parts located close together in a piece of equipment. It is not a separate type of flexible shaft but rather an added application of flexible shafting.

The coupling can be composed of either power drive or remote control flexible shafting although the latter is generally used due to the added advantage of its ability to rotate both clockwise and counterclockwise. Generally used between two units which are but a few inches apart, coupling may transmit power between any two parts regardless of their relative positions.

For example, the diagram above shows an advantage in using small lengths of flexible shafting in a coupling application. Although the drive end and the driven end are not exactly in line, the coupling compensates for the difference in alignment between the two.

Many manufacturers use flexible shaft coupling even where parts may be connected by solid shafts because of the savings realized in the initial and the maintenance costs as well as in time and labor.

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columns when the material does not follow Hooke's law; a section on torsion of tubular members with intermediate cells; a rewritten chapter on deformations beyond the elastic limit with a complete discussion of the behavior of beams of perfectly elastic materials; and a discussion of the ultimate strength of structures, the basis for limit design.

Some of the advanced topics discussed in this book are: beams on elastic foundations; combined axial and lateral loads; thin plates and shells; buckling of bars, plates and shells; and stress concentration in various configurations.

How to Become a Registered Professional Engineer

JOHN D. CONSTANCE, *The M. W. Kellogg Co. 11 x 8½ in., paper-bound, 11 pp. Published by Amer. Soc. of Tool Engrs., 10700 Puritan Ave., Detroit 38, Mich., $.25—members; $.50—nonmembers with minimum order of $1.00 required.*

Registration laws regulating the practice of engineering have been enacted by all of our states, the District of Columbia, and our territorial possessions. These laws establish the minimum qualifications of education and experience required of those who would practice or offer to practice professional engineering.

This paper advises the individual engaged in engineering work about the requirements for licensing on the basis of experience, education and endorsement as practiced in the various states and provides a list of individuals and agencies to be contacted for further details.

Handbook of Fastening and Joining of Metal Parts

V. H. LAUGHNER, *Editor, Modern Materials Handling, and A. D. Hargan, formerly Supervising Design Engr., Bell Telephone Labs., Inc. 9 x 11 in., 656 pp. Published by the McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N. Y. $15.*

This is by far the most comprehensive and useful book on the subject that has ever been published. It cov-

(Continued on page 379)

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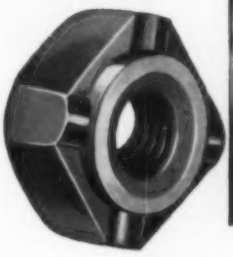

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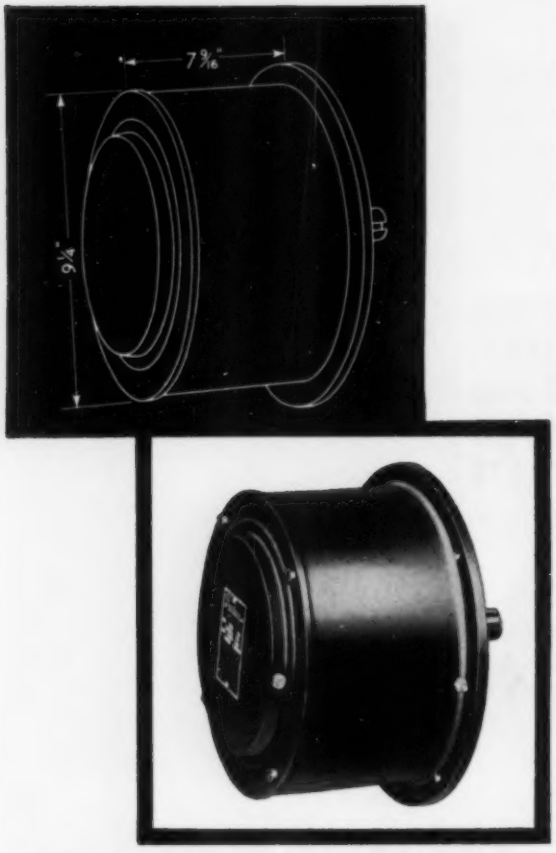

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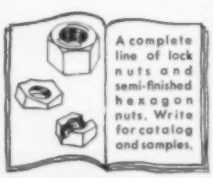

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ers all commonly used methods of fastening and joining including threaded fasteners, lock nuts, riveting, staking, welding, brazing, bonding with adhesives and other mechanical fasteners such as couplings, clutches, keys and splines.

The material is divided into two parts: the first section of the book discusses the advantages, limitations and other design and performance characteristics of the above-mentioned fabrication techniques and equipment.

The second section of the book is perhaps the most useful to the design and production engineer. It consists of numerous individual articles in sketch-caption form. Each article is intended to show as many different ways of accomplishing a given design function as possible. For example, there are articles devoted to showing different ways to lock threaded fasteners; how to prevent backlash in threaded parts; methods of holding and joining electrical wiring, etc.

Data from this book was compiled from three principal sources: the editorial pages of *Product Engineering*; a manual compiled by the engineers and technicians of Bell Telephone Labs., Inc.; and standards compiled by the American Standards Association and published by the American Society of Mechanical Engineers.

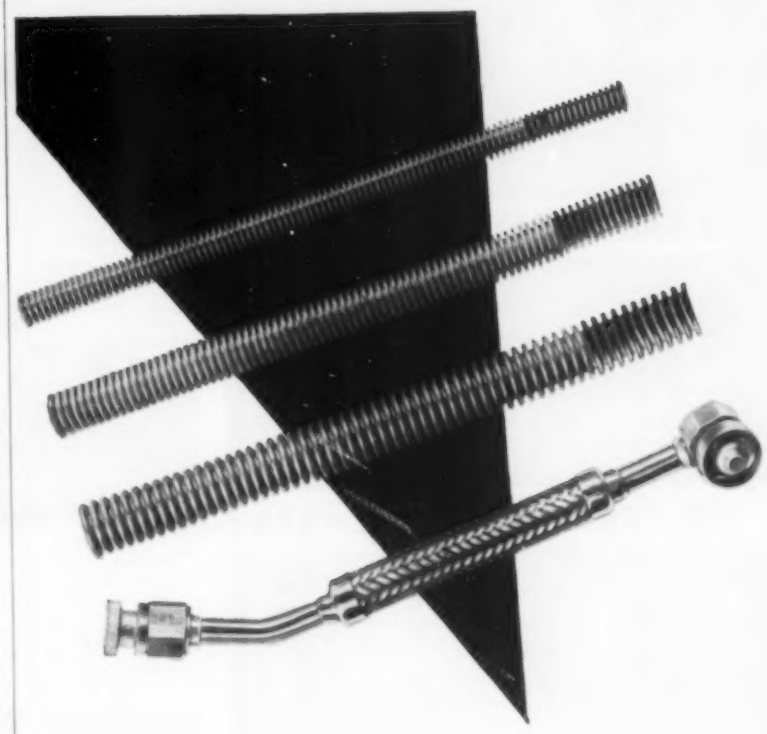
Resistance Welding Theory and Use

Prepared by the AWS Resistance Welding Committee, 6 x 9 in., 163 pp. Published by Reinhold Publishing Corp., 430 Park Ave., New York, N. Y. $4.50.

The book gives an understanding of the basic principles of resistance welding as vital to effective use of the process. The information supplied, while not all necessarily new, is the result of thoughtful evaluation and rational arrangement. It covers all the resistance welding processes, machines, controls and electrodes.

Of special interest is a chapter on welding symbols and one on weldability of metals.

Simplified drawings, including a master chart of welding processes and a list of definitions of resistance welding terms, increase the usefulness of the book.



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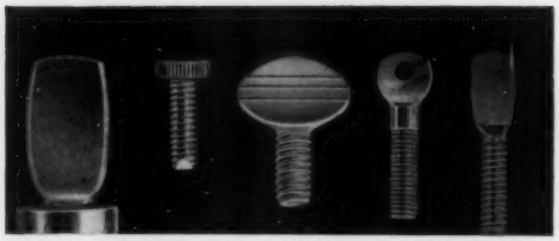

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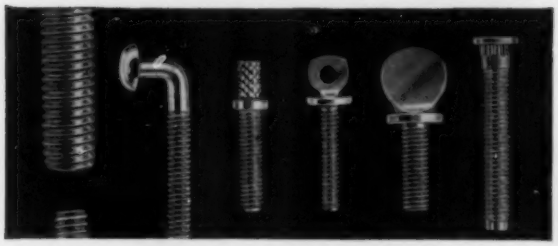

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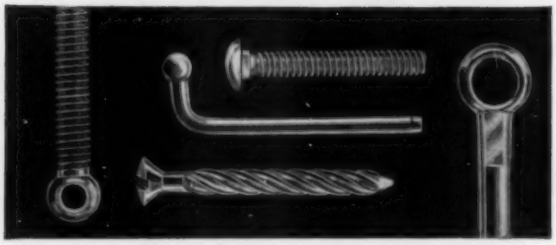

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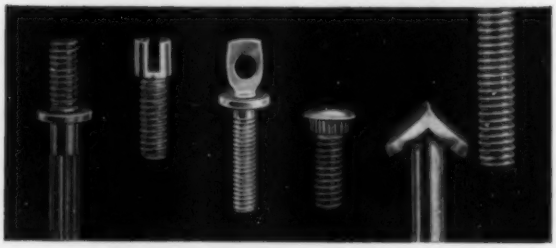
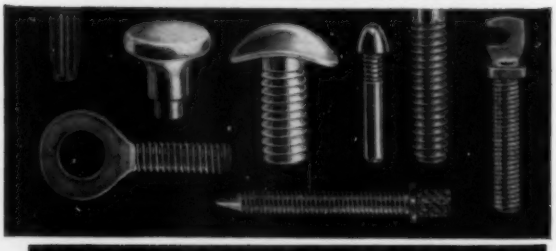


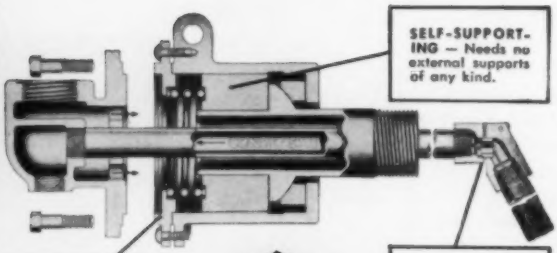
FOR COLD FORMING . . .



MACHINE SCREWS AND SPECIAL FASTENERS ARE OUR BUSINESS
. . . INCLUDING SQUARE AND HEXAGON MACHINE SCREW NUTS

WRITE FOR OUR CATALOG

THE PROGRESSIVE MANUFACTURING COMPANY
DIVISION OF THE TORRINGTON COMPANY
48 Norwood St., Torrington, Conn.


SELF-SUPPORTING — Needs no external supports of any kind.
ASSEMBLY PLATE — Holds internal parts in position when head is removed.
SYPHON ELBOW — Permits use of straight pipe for syphon. Can be inserted or withdrawn right through the joint.

Johnson Rotary Joint with SYPHON ELBOW

Johnson Joints represent the best way industry has yet found to get steam or liquids into rotating rolls and cylinders. They are completely packless, need no lubrication or adjustment. The Type SBP shown gets steam in, condensate out, through the same head. Other types available for through flow service, in sizes to meet all operating needs. *WRITE FOR COMPLETE INFORMATION.*

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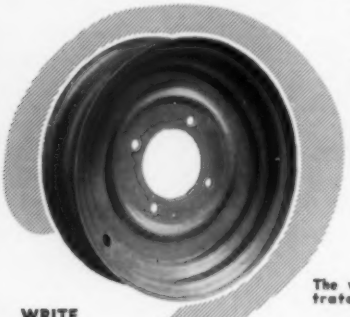
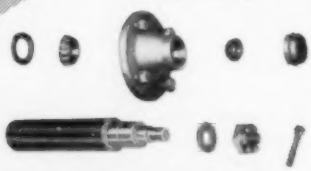
The full values of your mobile equipment are realized *only* when the CORRECT wheel selection is made.

We have many standard wheel-hub-spindle assemblies from which your needs can successfully be met — specials, too, when required.



The wheel and parts illustrated are our 12-4 LM Timken Series.



WRITE *for* "LOW LOAD ECONOMY SERIES" BULLETIN 127

F&H *Describe your application and we'll send Recommendations and Prices.*

FRENCH & HECHT
DIVISION
KELSEY-HAYES WHEEL COMPANY
DAVENPORT, IOWA

OUR READERS SAY . . . . . .

Letters should be addressed to the Editor, *Product Engineering*, 330 W. 42 St., New York 36, N. Y.

More Information Wanted

To the Editor:

Two articles in the Developments to Watch section of the June, 1956, issue of *Product Engineering* have created considerable interest in my department. These are: "A New Stress Analysis Technique", and "Additions of Zirconium Increase Fatigue Life". I would like to know if more technical information (reports, bulletins) is available on these subjects. If my inquiries should be directed to the organizations concerned, could you please give the names of persons and company addresses.

—L. E. Foglesong
Aluminum Co. of America

Ed—We have no further details yet on the two subjects about which you inquire. We are, however, listing below the addresses of the two organizations concerned. I am certain they will be pleased to furnish you with further information.

Zirconium Additions: British Non-Ferrous Metals Federation, 132, Hagley Road, Birmingham 16, ENGLAND.

Stress Analysis Technique: Mr. Marc Wood, Marc Wood International, Inc., 30 Rockefeller Plaza, New York 20, N. Y. The new stress analysis technique, PhotoStress will be the subject of a 12-page special report to appear in the September issue.

Plastics for Industrial Use

To the Editor:

We appreciate the coverage which your special report (Plastics for Structural Uses, June 1956) gives several of our materials. However, the comparison illustrated in Fig 11 is between unmodified Teflon and Teflon reinforced with ceramic fiber rather than glass fiber as stated. Ceramic rein-

(Continued on page 383)

ENGINEERS and **TESTING CHIEFS**

These are career opportunities for resourceful supervisory engineers with experience in design, development or evaluation of civilian goods; also for assistants to division head.

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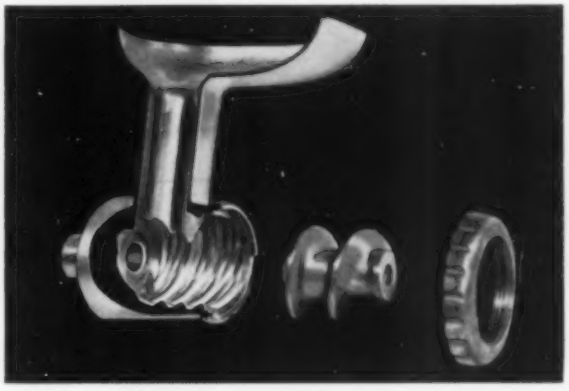
The firm is well known and maintains high professional standards. Location: in the suburbs near metropolitan New York City.

$10,000 to $17,000 FEE PAID

Advanced degrees are desirable though not mandatory. The age bracket is 30-54 years. Address resumes to David L. Golan, 100 West 42nd St., Room 203, New York, N. Y.

SUBURBAN EMPLOYMENT, Inc.
AGENCY



With proper engineering and die cast technique, threads are cast to size with the typical aluminum die cast smooth finish.

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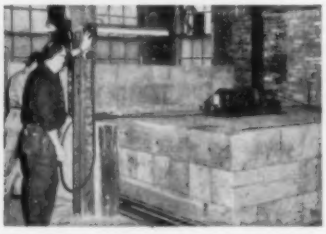
First they are put in a deep, armor-plated, concrete test pit.

Then fastened on a shaft that spins the clutch at high speed.



The clutch is spun, and highest R.P.M. recorded.

Let us help insure fully-tested clutches for YOUR products.

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Automotive Spring Loaded

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Oil or Dry Multiple Disc

Heavy Duty Over Center

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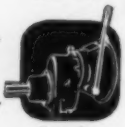
Power Take-Offs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36 So. Wabash, Chicago 3, Illinois

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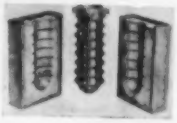
with CERRO ALLOYS you can reduce costs of: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—and many other operations such as making dies, anchoring bushings, securing magnets in fixtures, anchoring shafts in Alnico rotors, aligning and securing shaft bearings, etc., etc.

CERRO ALLOYS melt at low temperatures and are non-shrinking (even expand slightly) in hardening. Send for literature, mentioning operation in which interested.

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NICE BALL BEARING COMPANY
NICETOWN PHILADELPHIA PENNSYLVANIA

forced material has substantially lower deformation under load than conventional glass filled material.

—R. C. Berry
Rogers Corporation

To the Editor:

In your special report on Plastics, Table III on page 171 shows Izod impact strength of Cycolac as 1.60 ft lb at 40 F. The impact strength shown is for −40 F. While we have no data for 40 F, tests at 32 F show an impact strength of 3.5 ft lb, more than twice the figure given in the table.

—C. R. Holt
Marbon Chemical Division
Borg-Warner Corp.

Foreign Requests for Literature

To the Editors:

Would you kindly arrange to have forwarded to us literature referred to on the numbers circled on the enclosed Readers' Service card. We have from time to time made certain small requests but we notice that we do not receive all those publications asked for and consequently are not obtaining the best use of your magazine.

We would appreciate it if you would follow up our requests to see that the publications requested are forwarded. —John G. Henderson
Henderson's Federal Spring Wks. Ltd.
Melbourne, Australia

To the Editor:

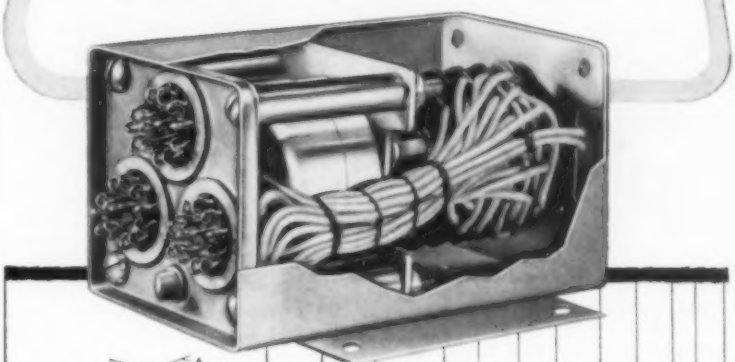
We are subscribers to your periodical and from time to time wish to obtain trade literature offered therein. Whenever we have used the detachable Readers' Service cards, however, we have received no reply to our request, and, in consequence, have found it necessary to write individual letters.

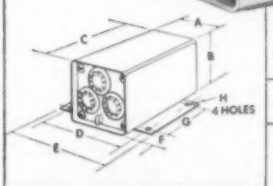
It would appear that these cards are intended for U. S. subscribers only, and we should be most grateful if you would inform us whether this is the case. —C. F. Cayless
Vickers-Armstrong Ltd.
Winchester, Hants., England

Ed—The Readers' Service card you returned with your letter has now been processed and your requests for specific information have been forwarded to the various interested companies. The

(Continued on page 384)

NEW LEDEX
HERMETICALLY SEALED ROTARY SELECTOR SWITCHES AND STEPPING RELAYS





MODEL	MAX. NO. WAFERS	MAX. NO. HEADER PINS	A	B	C	D	E	F	G	H
No. 4	4	45*	2¼"	2⅜"	4½"	2¹¹⁄₁₆"	3⅛"	¾"	3"	3⁄16"
No. 5	4	105*	3⅞"	3⅜"	5⅜"	4⅝"	4¾"	²⁵⁄₃₂"	4"	3⁄16"

*Circuits should allow for header pins to carry arc suppression items externally

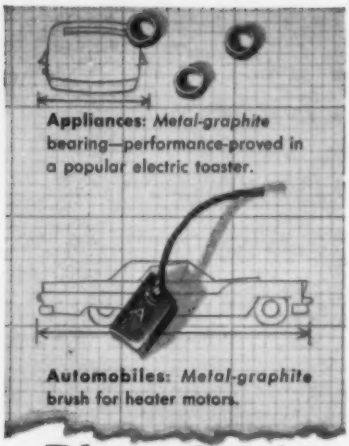
THESE STANDARD HERMETICALLY SEALED ENCLOSURES ARE NOW AVAILABLE FOR LEDEX

Hermetically sealed Ledex switches are moisture-proof, dust-proof and protected from the effects of salt-spray, fungus and humidity. Also, many of the hermetically sealed Ledex selectors qualify for the requirements of MIL-E-5272A. Ledex selectors simplify installation problems, reduce wiring time to a minimum and prevent damage caused by tampering.

Many switching combinations are available with the standard models. If the standard models do not answer your specific requirements, send the salient facts of your special hermetically sealed selector switch problem to us for our recommendations.

For best delivery specify one, ten or fifteen pin headers. (Illustrated)

G. H. Leland INC.
WRITE FOR COMPLETE INFORMATION TODAY!
123 WEBSTER STREET, DAYTON 2, OHIO



Appliances: *Metal-graphite* bearing—performance-proved in a popular electric toaster.

Automobiles: *Metal-graphite* brush for heater motors.

Blueprint for

PROFIT

with

PRECISION-MOLDED CARBON PARTS BY

Speer

Carbon – one of industry's most versatile materials–constantly finds new applications in the latest product designs.

Precision-molded carbon parts by Speer have improved product designs ...cut production costs–for hundreds of manufacturers.

Carbon Is Really Versatile!

Carbon can be:	Carbon has:
Sawed	High corrosion resistance
Drilled	High heat transfer
Milled	Low electrical resistance
Broached	High thermal shock resistance
Turned	
Planed	Carbon is:
Hobbed	Not wetted by molten metals
Ground	Non-warping
Molded	Chemically inert
Extruded	Self-lubricating

Let Speer engineers and designers help you discover the many advantages – and economies – that carbon can bring to your product!

SPEER Carbon Co.

St. Marys, Pennsylvania

Please send me information on:
— Molded carbon parts
— Machined carbon parts

Name_____

Title_____

Company_____

Address_____

City_____ Zone____ State_____

reason you may not be receiving all the catalogs and bulletins you request is that some companies do not have the facilities for handling foreign requests—usually because their setup is too small. Unfortunately, it would be impossible for us to follow up on those publications not sent.

The only suggestion we can make is that, on those publications not received after a reasonable length of time, you write direct to the company concerned. I can assure you that most U. S. manufacturers are quite eager to receive inquiries from abroad and to send brochures telling the full story of the products they manufacture.

Nuclear Reactors

To the Editor:

The article on nuclear reactors which appeared in the April issue of *Product Engineering* is an excellent presentation of the major engineering problems that occur in designing components and controls for nuclear reactors. It would be helpful to have additional copies of this article to distribute among our engineering personnel.

Accordingly, this letter is written to determine whether it would be possible for us to purchase fifty reprints. —J. Warren Gillon
American-Standard Atomic Energy Div.

Ed–Reprints of this report are available at 30¢ per single copy, 28¢ per copy in lots of 100 or more.

Reduced Drafting Costs

To the Editor:

Your thought-provoking article, "Cutting Costs on Prototypes and small Lots", in the March 1956, issue contained reference to several past articles concerning reduced drafting costs. We would be very much interested in obtaining a copy of these articles. —Clyde W. Robinson
Sanders Associates Inc.

Ed–Unfortunately, we no longer have copies of the articles you list except for the two most recent ones. The article in December was an editorial by Mr. Nordenholt, and the February

(Continued on page 385)

CABLE CLIPS

★ *of all Nylon* for severe conditions ★ *of Ethyl Cellulose* for maximum economy

WECKESSER

molded Black Nylon **SCREWS and NUTS**

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and April 1954 articles were "Letters to the Editor" in response to that editorial. The only way we can supply copies of the missing articles is by photostating them from our bound volumes at 40¢ per page.

Weld Splatter Shielding

To the Editor:

I would appreciate any information in regard to a sheet material which could be used for shielding machine parts from welding flash. In our rail welding operations some of the machine parts are within 3" of the joint which is being welded and are easily damaged unless protected by some kind of shield. E. F. Cox

Matisa Equipment Corp.

Ed–Minnesota Mining and Manufacturing Company of St. Paul, Minnesota have available a liquid that is painted on the machine surface to be shielded. They also have strips with an adhesive backing similar to "Scotch Tape" that can be pasted on the surface to be protected. In both the tape and the painted on material, the basis is a vinyl resin. Both of these coatings peel off after they have hardened and are no longer needed.

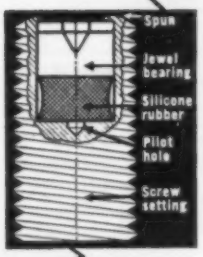
Making Stress Visible

A new technique based on photoelasticity–recently developed in France and available here soon–offers the opportunity to see surface stress patterns on actual parts regardless of size or shape.

In a special report in the September issue, page 167, the developer of the PhotoStress system, Ing. Dr. Par F. Zandman, describes the method, equipment used in measuring and recording stress patterns, and procedure for evaluating direction and intensity of principal stresses.

System makes use of a special clear plastic with birefringrant properties, available either in sheets for cementing to flat surfaces, or as a liquid coating. Under polarized light fringe patterns reveal the stress pattern.

Be SURE of SHOCK PROTECTION for delicate instrumentation



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Bird jewels with resilient silicone rubber or spring cushions provide inexpensive shock resistance for any instrument. Bird provides variable cushioning to suit different operating conditions; mountings to any specification; controlled movement of jewel.

Bird Cushion Jewel Assemblies add the necessary safety factor to your instrument production, eliminating waste and tear-down because of poor judgment in bearing adjustment.

Let actual tests prove the superb performance of Bird Cushion Jewel Assemblies. Send specifications and sizes of jewel bearings you require. Bird will send you samples for testing in your own plant. Bird engineers are available for all your small bearing problems.

Over 40 years of serving industry with Quality jewel bearings

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Sapphire and glass jewels Precision glass grinding Jewel mounting and assembly Sapphire styli

20 Spruce Street, Waltham 54, Mass.

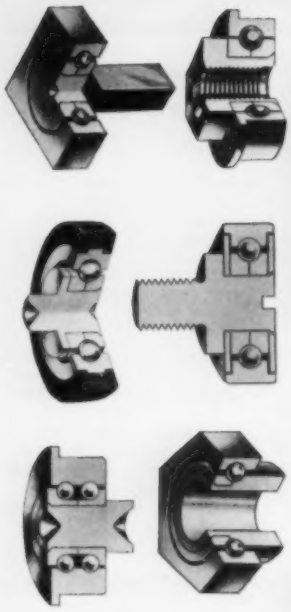
RAWSON

4 PURPOSE COUPLING

Rawson Couplings will enable your motors to start heavy loads in seconds, keeping down your electric power demand charge. Made up to 1000 h.p. Simple in action; effective in service. Rawson is a 4-purpose coupling—transmitting smoothly loads between motor and machine—hundreds of applications—*Starts . . . couples . . . cushions . . . limits load.*

RAWSON COUPLING DIVISION

O. S. WALKER CO. INC. WORCESTER, MASSACHUSETTS



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Long life and service are assured you because —

1. All component parts are machined from steel bars.
2. Each component part is properly heat treated.
3. Every Kilian Bearing is designed for a specific application.

Neoprene and Nylon tired outer races are available where quiet operation is desired.

Distributors in All Principal Cities ***Catalog on Request***

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ASSOCIATED COMPANIES:
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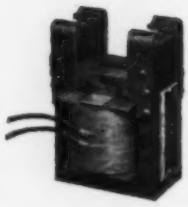
Fischer Bearings (Canada), Ltd. 240 Fleet St. East, Toronto 2B, Ont.
Kilian Steel Ball Corporation 100 Wellington St., Hartford, Conn.

SOLENOIDS

G-211 solenoid, 10 lbs. at 85% voltage, 1½" stroke.



NA-726 solenoid; 16 lbs. at 1" stroke, 100% voltage.

G-200 line of solenoids. Replacement for all sizes of General Electric Co.'s CR-9503-200 line of solenoids.

NA-700 line of solenoids, replacement for National Acme solenoids, size for size, for all modifications.

The solenoids of both the above replacement lines are all thoroughbred Trombetta solenoids. All dimensions of interest to the user are the same as the respective solenoids they replace. The pull and pull characteristics are identical. In either case, we are in a position to furnish replacement units for any and all modifications. They are available for all voltages and frequencies, including direct current.

See our catalogs in Sweet's Catalog Service. Ask for more information.

TROMBETTA SOLENOID CORP.

329 N. MILWAUKEE STREET • MILWAUKEE 2, WISCONSIN

PRECISE **miniature differentials**

Visit our Booth No. 910-911 WESCON SHOW Los Angeles Aug. 21-24

Hollow shaft construction permits easy mounting in minimum space. Although extremely small and light, these differential gear units exhibit exceptionally low backlash and friction.

Removable end gears make these units particularly flexible.

Write for technical data.

Backlash less than 0° 7' standard, and less than 0° 3' special.

Breakaway torque at zero load: one gear locked —0.007 oz-in. with shaft locked—0.010 oz-in.

End gears interchangeable; supplied in 48, 64, 96 or 120 pitch.

Stainless steel throughout.

Weighs only 0.88 ounce.

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SRVS8

PRESS PREVIEWS

Sperry Ultrasonics Caravan Scheduled for 48-State Tour

Ultrasonic inspection equipment fitted into a trailer caravan for plant-side demonstrations of nondestructive testing of materials and machinery is being sent by Sperry Products, Inc., of Danbury, Connecticut, on a 48-State tour of American industrial centers. Initial stops are scheduled for Cleveland and Detroit. It will give plant-side demonstrations enroute and is expected to reach the Middle Atlantic states in November.

The $60,000 exhibit includes operating equipment for contact and immersion testing with the Sperry Simac and Reflectoscope. Included is the UWA-B Reflectoscope combination capable of locating and evaluating microscopic subsurface flaws in

metal as little as one-quarter inch thick and 100 feet long. The Reflectoscope's B-Scan unit not only locates defects, but reveals them in cross-section on a television-type screen. Large calibrated meters make possible observation from across a room.

The caravan presents also a strip tester for continuous inspection of metal strip. This device is automated, with flaws signalled by light, bell or both, and recorded by camera or on Brush Recorder tapes. Equipment for immersion testing includes inspection tank, positioner, carriage, camera attachment, magnifier and remote signals. Contact testing is demonstrated with the Type UR Reflectoscope, type UG Reflectogage and the automatic continuous strip tester.

Visiting industrial plants, for

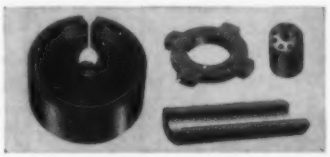
(Continued on page 389)

Engineering FACT SHEET

CARBOLUBE

Self-Lubricating Bearings, Bushings, Seals, Contacts, Parts

WHEN LUBRICATION IS IMPRACTICAL OR IMPOSSIBLE SPECIFY CARBOLUBE



Typical examples: Valve Parts, Bearings, Friction Clutches, Seal Rings, Sliding Contacts, Piston Rings, Pistons

CARBOLUBE IS APPLICABLE WHERE:

1. Oil lubrication is inconvenient, expensive or impossible
2. Chemical corrosion attacks oil, grease
3. Bearings, seals or parts are inaccessible
4. Extreme temperatures reduce operating efficiency or make lubrication inefficient
5. Current is transferred between moving parts
6. Weight reduction is necessary
7. Bearings, seals or parts are submersed in liquids
8. Lack of fumes, cleanliness are necessities
9. Electrical parts are subject to pitting or fusing

CHARACTERISTICS OF BABBIT & COPPER CARBOLUBE

(Range between limits, according to grades)

Weight: 1¾ to 3 oz./cu. in.

% of Metal (by weight): 35%—70%

Tensile Strength: 3,900—5,500 lbs./sq. in.

Compressive Strength: 16,000—30,000 lbs./sq. in.

Coefficient of Friction: constant and low.

Coefficient of Expansion: approx. ½ that of iron or steel.

Bearing Load Pressure: 20-50 lbs./sq. in. on the projected area.

Speed: 1,500—7,000 FPM, depending on grade.

Operating Temperature:
Babbitt, to 350 F.*
Copper, to 750 F.*
Non-Metallic, to 750 F.*

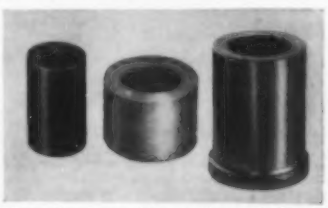
*In air or oxidizing atmospheres. Higher temperatures allowable in non-oxidizing atmospheres.

Machined Molded Parts

Corrosion-Resistant, Metal-Impregnated or Plain Carbon Bearings or Other Parts. . . . Need No Oil or Grease

Carbolube is carbon-graphite impregnated with babbitt, bronze, copper, cadmium, silver or non-metallics. The result is a completely homogeneous material whose self-lubricating and corrosion-resistant qualities are *inherent*, regardless of wear.

Formed by molding under carefully controlled conditions, Carbolube products are available in a great range of metals and carbons adaptable to your specific needs. Carbolube is also available in *non-metallic* impregnated parts. Write for complete engineering data indicating your specific application.



Plain Bearings: Thrust, Journal, Guide

BACKED BY YEARS OF RESEARCH AND DEVELOPMENT

Carbolube is a product of the Carbone Corporation, American manufacturing affiliate of one of the world's greatest manufacturers of mechanical carbon—Soc. Le Carbone-Lorraine.

Carbolube was first produced in 1950, embodying the most advanced ideas in the field.

Years of research have resulted in a complete series of grades of Carbolube for almost every specific application within the range of mechanical carbon parts. Our technical staff will gladly help to solve your specific design problem.

AVAILABLE IN A WIDE RANGE OF TYPES AND PRODUCTS

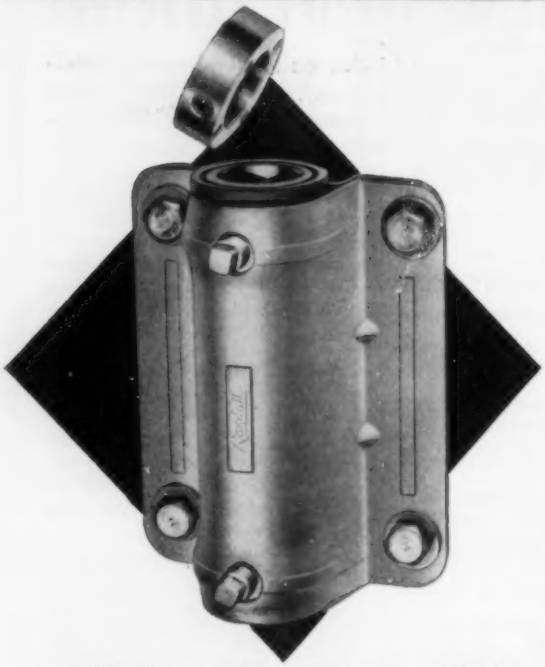
THE CARBONE CORPORATION BOONTON, NEW JERSEY

"new"

RANDALL

DUPLEX

SLEEVE BEARING ASSEMBLY



specially designed for vertical or thrust loads

The first self-aligning duplex bearing assembly in the low cost field. Now—the NEW Randall Duplex Bearing Assembly offers a practical, low cost solution to many vertical or thrust load problems. It is composed of a rugged housing incorporating two Randall graphited bronze bushing "Deep-Well"® ball assemblies. A special graphited flanged bushing and unique thrust collar have been designed for vertical or thrust load applications. Available in ¾" and 1" shaft sizes.

it gives you these outstanding features

The efficiency of this assembly has been proven by extensive testing under all operating conditions.
Completely self-aligning, self-lubricating, quiet in operation.
Pre-lubricated at the factory with Plastic Petroleum E, a long-life lubricant which greatly reduces maintenance.
Long, trouble-free service.
Housing finished in corrosion resisting baked aluminum paint. Lends itself to simple, low-cost mountings and blends with functional, modern designs.

for horizontal application

Does not require ball assembly with special flanged bushing or thrust collar.
Choice of quality graphited bronze bushings or the low-cost sintered bronze.
Choice of pre-lubricated Plastic Petroleum E, oil or grease style lubrication. Range of shaft sizes ½" to 1".

BRONZE BAR STOCK
BRONZE BUSHINGS
PILLOW BLOCKS
SHEET LUBRICATOR
GRAPHITED BEARINGS
THRUST WASHERS
SAFETY COLLARS
BRONZE CASTING

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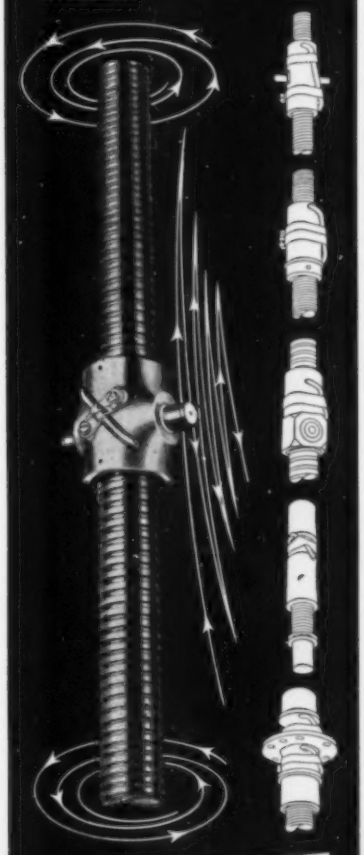
ball screws

Successor to the Acme screw drive and preferred in many applications to hydraulic and pneumatic systems. Guaranteed 90% efficiency in converting rotary twist to linear push (or vice versa). Employs a stream of precision balls and ground lead to eliminate drag and wear in delicate instruments to massive wind tunnel jacks. Any diameter or travel: indexing, inching, traversing. Literature, consulting engineering service available.



Fastest growing source for ball screws

Beaver Precision Products INC.
CLAWSON, MICH.

demonstrations conducted by Sperry field engineers, the caravan functions as a travelling laboratory in which metallurgical, quality control and production engineers may learn methods and potentialities of nondestructive testing with ultrasonic instruments.

The tentative travel schedule includes Toledo, Cleveland, Dayton, Cincinnati, Detroit, Chicago, Milwaukee, Spokane, Seattle, Portland, San Francisco, Los Angeles and San Diego. The caravan travels under its own power and generates its own electricity for demonstrations.

IBM Expands Typewriter and Computer Facilities

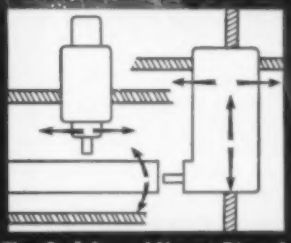
International Business Machines Corporation recently announced plans for two more major projects in its nationwide expansion program—construction in Lexington, Ky., of additional manufacturing facilities for the company's Electric Typewriter Division, and construction of a laboratory at Kingston, New York for the Military Products Division.

Previously announced this year have been construction of plant, laboratory and educational facilities in San Jose, Calif., and Rochester, Minn., a 12-story office building in Los Angeles, office buildings in several other cities, and a plant and laboratory for production of Bombing-Radar Navigation Equipment (BRANE) at Owego, N. Y.

H. W. Miller, Jr., general manager of the Electric Typewriter Division, said that the Lexington operation would augment Kingston production

(Continued on page 390)

The same mechanism that controls the horizontal tail may improve your machine tool



The G. & L. and Hypro Div. of the Giddings & Lewis Machine Tool Co. uses 4 Beaver Ball screws (up to 16' long) per machine for automatically positioning heads and swiveling the work chuck of their numerically controlled skin mills—shown here machining wing skin for a jet fighter aircraft.

Our engineers are available to discuss machine design problems with you.

Beaver Precision Products INC.
CLAWSON, MICH.

CASE HISTORIES
Die Casting Houses *
Radio Antenna Drive
To Eliminate a multiple-piece assembly, a one-piece zinc die casting was selected for the housing of an electrically-driven radio antenna, shown. Use of zinc for the housing also provides improved corrosion resistance without finishing, and reduces machining and assembly operations. Manufactured by the Pioneer Specialty Company, Detroit, the unit is currently being used on the 1956 Cadillac.

DIE CASTING BY PARAMOUNT

5 REASONS WHY

A DIE CASTING PRODUCED A BETTER PART FOR LESS

1. **Eliminated a multi-piece assembly.**
2. **Improved resistance to corrosion.**
3. **Eliminated finishing.**
4. **Reduced machining operations.**
5. **Reduced assembly operations.**

The total result is a part produced of the *finest quality* at the *lowest possible cost!* Call in a PARAMOUNT sales engineer today, let him tell you the complete story.

*PARTIAL REPRINT—
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April, 1956

WRITE FOR FREE
DESCRIPTIVE BROCHURE

ALUMINUM ZINC MAGNESIUM
Paramount
DIE CASTING COMPANY
ST. JOSEPH 12, MICHIGAN

which got under way recently with a shift of most typewriter manufacturing from the company's Poughkeepsie plant to this location. This 30-mile overnight shift was accomplished in 10 hours, the new facilities going into operation the following day with an eight per cent increase in production over that of an average day in the Poughkeepsie plant. Typewriter operations continuing at Poughkeepsie will be discontinued gradually as the Kingston and Lexington plants reach full production.

The Lexington plant will be a 386,000 sq. ft. building on a 278-acre site north of the city on the Belt Line Highway. A 40,000 sq. ft. building will be ready for occupancy and training operations in late 1956, and the remainder will be completed by the summer of 1957, when about 1,800 people will be employed. Presently, IBM employs approximately 4,900 people in its Kingston operations, 3,100 in defense work, and 1,800 in the typewriter plant.

New laboratory for IBM's Military Products Division will be built on presently-owned land opposite the Kingston plant. Construction on the 150,000 sq. ft. building will begin in the fall of 1956. It will accommodate 700 employees now employed elsewhere on research and development in connection with the computers being produced for SAGE, the Air Force's continental air defense system. The first large-scale SAGE computer has been shipped from Kingston, N. Y. to McGuire Air Force Base in New Jersey. This "electronic brain" will become the first of the computers to fit into the integrated complex of radar, ships, jet aircraft, communications networks, missiles, and people that is rapidly taking shape as the continental air defense system.

This project, known as the Semi-Automatic Ground Environment (SAGE) system, combines the abilities of the world's fastest electronic computer to receive information, memorize, calculate, and record answers with the perspective and display talents of radar. It presents an instantaneous graphic picture of the location, speed, and direction of all planes within radar range. With a knowledge of flight plans of friendly planes available in the computer,

(Continued on page 391)

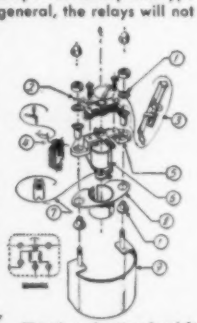
VHS* RELAY
(*Very High Sensitivity)

Model 266

Sample specs. are: 0.2 micro-amperes, (12,000 ohms coil) or, 0.1 millivolts, (5 ohms.)

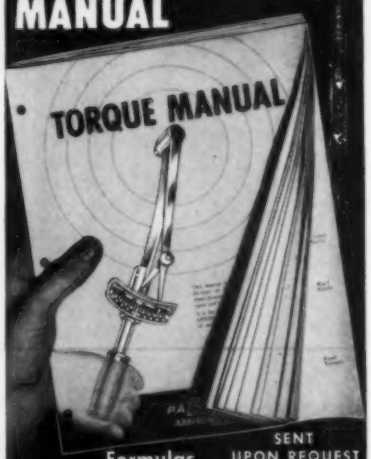
• The VHS is a balanced armature, Alnico magnet type relay. It is internally shock-mounted and resistant to vibration. The screw-on cover is gasket sealed. It can be opened and resealed.

Connections: 9 pin octal style. Dimensions: 1¾ diameter x 2¼ long. Weight: 4 ounces. Sensitivity: Infinite variations from 0.2 Ua. to 10 Amp. or 0.1 Mv. to 500 volts, self contained. Higher volts or amps with external multipliers. A.C. rectifier types. Trip point accuracies to 1%. Differential 1%. The degree of resistance to shock and vibration primarily depends upon sensitivity and type of action wanted. In general, the relays will not be permanently damaged by shocks of 100 G's and vibrations up to 2,000 cps at 4G's. The most sensitive relays may close their contacts under these conditions.



Contacts: SPST or SPDT, 5-25 Ma. D.C. Other ratings to ½ Amp. A.C. A locking coil gives high pressure and chatter free contact under shock and vibration.
Prices: $20-$80.
Delivery 4 to 6 weeks.
Assembly Products, Inc., Chesterland 55, Ohio.
Write for explanation of symbols
(West Coast: Desert Hot Springs 55, Calif.)
See us at WESCON Show, Aug. 21-24, Los Angeles

"TORQUE WRENCH" MANUAL



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Formulas
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Engineering Data
Screw Torque Data
Adapter Problems
General Principles

P.A. STURTEVANT CO.
ADDISON QUALITY ILLINOIS
Manufacturers of over 85% of the torque wrenches used in industry

hostile planes can be identified immediately and the most effective defense action taken—again on the basis of computer information and instruction.

The computer was designed by IBM in cooperation with MIT's Lincoln Laboratory, and was manufactured at the company's Kingston Military Products Division plant. The plans for production were laid in 1953 by IBM, with the first machine being completed and shipped in accordance with the schedule.

The SAGE system starts with a radar ring—on land, on Navy picket ships at sea, on offshore Texas Towers, and on airborne early warning planes ranging far out over the ocean. These radars are linked by telephone lines or ultrahigh-frequency radio directly to the high-speed computer. Information about aircraft anywhere within the radar area is relayed continuously and automatically to the computer. This IBM-built equipment, called the AN/FSQ-7, digests all of this information plus Ground Observer reports, flight plans, and weather information as fast as it is received and translates it into an overall picture of the air situation. These TV-like pictures show the air battle as it develops and provide the basis for the necessary human judgments.

The computer automatically calculates for the operator the most effective employment of such defensive weapons as guided missiles, anti-aircraft batteries, and jet interceptors. In the case of the intercepting jets, the aircraft is controlled by directions fed by radio directly from the computer to the automatic pilot in the plane. Missiles are controlled similarly. At any time, the air battle commander can have the computer display the

(Continued on page 393)

IN ADDITION TO ITS REGULAR LINE of precision gears, one of New England's oldest and ablest gear-engineering organizations is now fully equipped to produce fine pitch gears to your own specifications. Any size and quantity... any type of basic material, metallic or non-metallic. Complete heat-treating facilities.

Perkins has the equipment, the experience and the craftsmen to satisfy *all* of your custom-made gear requirements.

YOU FURNISH THE SPECIFICATIONS — WE'LL PRODUCE THE GEARS

PERKINS MAKES: bevel gears, ratchets, sprockets, ground thread worms, helical gears, spiral gears, spur gears-shaved or ground teeth, gear trains and assemblies, speed reducers.

* **The PERKINS PRECISION SPRING COILER is the latest development in the spring coiler field and eliminates entirely the use of arbors and long set-up time. It is a complete self-sufficient machine and enables you to make the spring you want when you want it — in seconds. The coiler produces any type of spring, in any diameter and any pitch with this range: Wire sizes .005 to .125. Diameter, from 3/32" to 12" and larger. Size of the compact coiler is only 7 1/2x16". A POWER MODEL is available. Information on request.**

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● These particular blowers were made for radio or electronic cooling application. But, Peerless engineers design and build blowers and fans to customer, government and association specifications every day. Custom-made installations are our specialty. We do the whole job . . . make the motor, the fan or blower . . . everything. Each unit is unconditionally guaranteed. Whatever your air flow requirements or application it will pay you to contact Peerless. Do it today.

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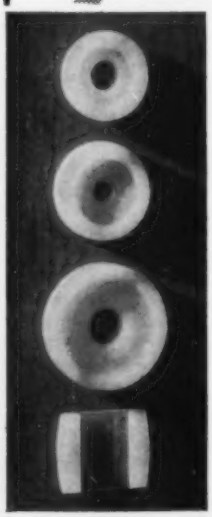
NYLON PLASTIC reduces kitchen noise!



Sinko Produces Nylon Parts That Give Years of Economical, Trouble-Free Service

Pictured are 3 Sinko Nylon cabinet rollers and a drawer skid-block that are being used successfully by several leading manufacturers of fine kitchen equipment. Sinko Nylon was selected after a series of exhaustive tests had proven its superiority in every respect. In one experiment a small drawer equipped with Sinko Nylon rollers was loaded and automatically operated the equivalent of a normal 200 years service. Upon examination the Sinko Nylon rollers showed little sign of wear.

You too should investigate the many advantages Sinko Nylon offers, among them—resistance to wear and to shock loads, to moisture, chemicals and to temperature; and its smooth-gliding, self-lubricating properties.

SINKO MOLDS ALL THERMOPLASTICS FROM 4 TO 100 OZ.

Sinko MANUFACTURING & TOOL CO.

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over-all air situation or whatever part of it he wishes to monitor in detail. As the battle moves, information is transferred spontaneously to an adjacent computer.

Typical of the many advanced electronic components in SAGE is a high-speed magnetic core memory, made up of thousands of tiny, doughnut-shaped cores. Several cores in a row store a single word or number, the identity of which is determined code fashion according to whether or not individual cores in the row are magnetized. Data may be "read" into or out of this memory in millionths of a second. The computer also makes considerable use of such new and economical developments as printed wiring and miniaturized components. Many automated and semiautomatic manufacturing techniques are used throughout. The AN/FSQ-7 is designed to operate 24 hours a day, 7 days a week. Facilities are provided so that preventive maintenance can be performed on the machine while SAGE data continues to be processed. The equipment going to McGuire is the first production computer. Engineering models of the computer have been installed for several months at Kingston and at the Lincoln Laboratory of Massachusetts Institute of Technology in Lexington, Mass., where the system is being tested.

The SAGE system was developed by engineers at MIT's Lincoln Laboratory under contract with the Air Force. This program is being implemented through the joint efforts of the USAF Air Materiel, Air Research and Development, and Air Defense Commands. Included among other contributors to the SAGE system are Western Electric Co. and Bell Telephone Laboratories of the American Telephone and Telegraph Co. and Rand Corp. of Santa Monica, Calif.

American Brass Co. Breaks Ground for Aluminum Mill

Ground-breaking ceremonies were recently held at the plantsite of American Brass Company's $25 million integrated aluminum mill near Terre Haute, Indiana, which will produce aluminum ingots and billets, rolled

(Continued on page 395)

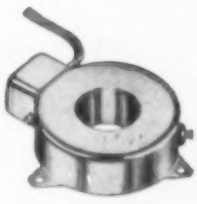
Are Your Components Guilty of RADIO NOISE?

POTTER *can tell you "why"*

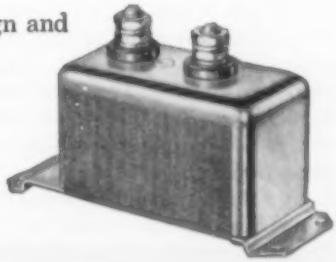
POTTER *can tell you "how"*

and **POTTER** *can make the FILTER that will confirm that "how"*

Once it's stated completely and correctly, a problem is half solved. Potter can put the facts and figures of your problem on paper . . . can chart its limits in laboratory tests . . . can engineer the solution. And Potter can embody that solution in subsequent design and production.



Call Potter to engineer, design and produce the filter to solve your radio interference problem. Write for Bulletin 41 H.



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1950 SHERIDAN ROAD
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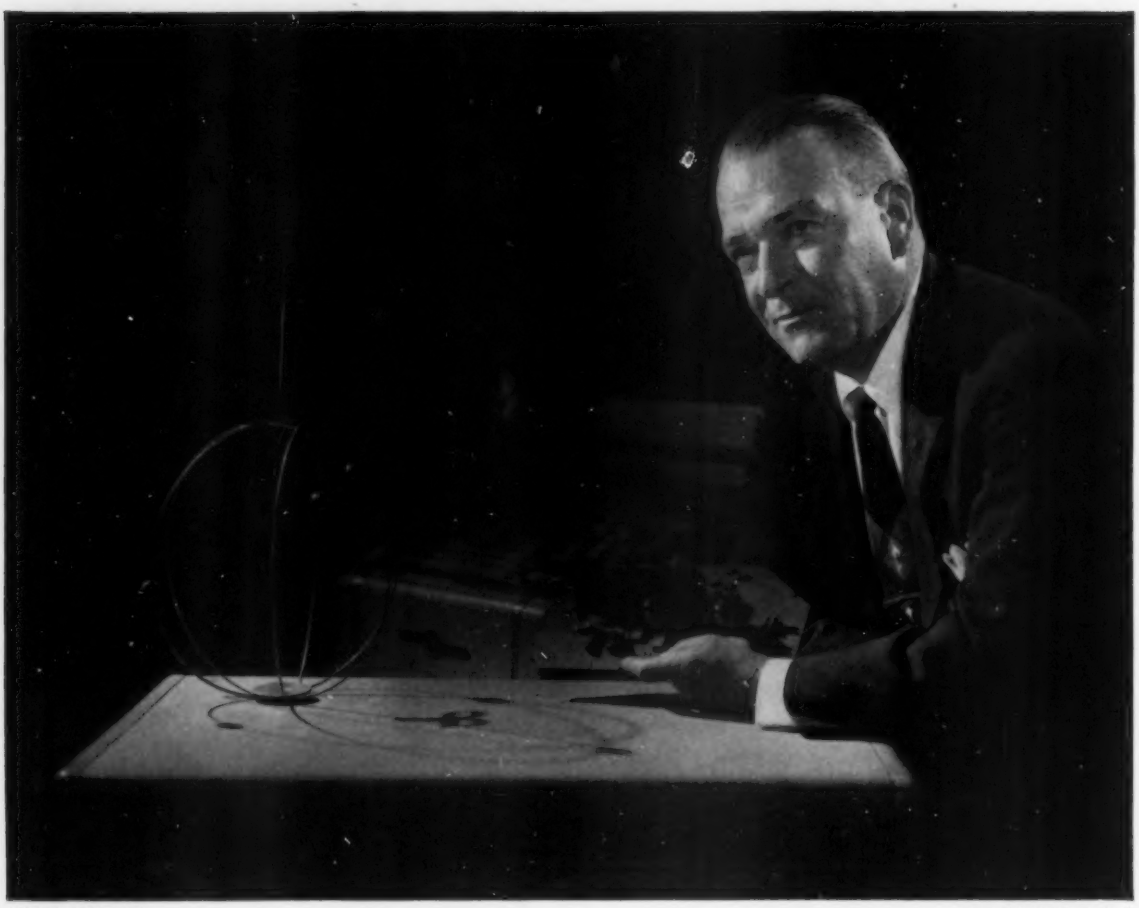

JOHN S. COLEMAN

Portrait by Fabian Bachrach

"I am proud that 80% of Burroughs Employees..."

"I am proud that 80% of Burroughs employees are enrolled in systematic savings in U. S. Savings Bonds through the Payroll Savings Plan. The record of the response of our men and women to our recent campaign speaks for itself. It is evidence of the desire to save, and to save in a way which benefits both the individual and the nation. I hope that every employer will take advantage of this opportunity to serve the interest of both his employees and the country by cooperating with the Department of the Treasury in the U. S. Savings Bonds campaign."

JOHN S. COLEMAN, ***President***
Burroughs Corporation

What is the percentage of employee participation in *your* Payroll Savings Plan?* If it is less than 50%, your State Sales Director will be glad to show you how easy it is to raise participation to 60% or higher. He will furnish Payroll Savings Application Blanks, and all the printed promotional material you can use. Write today to Savings Bonds Division, U. S. Treasury Department, Washington 25, D. C.

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Product Engineering

sheet and strip, and extruded tubes, rods and special shapes. The aluminum reduction plant at Columbia Falls, Montana, which began operation in August, 1955, with an annual capacity of 60,000 tons of ingot aluminum, will be a source of supply for the Terre Haute mill.

The plant is now under construction on a 315-acre site in Otter Creek Township, four miles north of Terre Haute Center. The new mill, a one-story building constructed of heavy steel, together with separate buildings to house an office and research laboratory, will cover a space in excess of 500,000 sq ft. The new mill will require a working force of 1,000 people, nearly all of whom will be recruited locally.

AMF Dedicates Laboratory in Raleigh

One of the most modern industrial research centers in the South is the recently opened Raleigh Laboratory of the American Machine and Foundry Company. It was established in January, 1951 to be near to the major cigarette manufacturing centers. A small mechanical and electrical development group has now been transferred to Raleigh from AMF's Brooklyn Engineering Department, to form the nucleus of the new laboratory.

The new 20,000 sq ft building is divided into three major development sections—electrical, mechanical, and electro-chemical. The Electrical Engineering Section engages primarily in the development of industrial measurement and control devices, utilizing dielectric and radioisotope instruments in conjunction with automatic controls. The Mechanical Engineering Section carries out the development and design of new high-speed production machinery, principally for the cigarette industry, although it has been doing experimental work in the field of automation. The Electro-Chemical Engineering Laboratory has pioneered in the development of new silver-zinc and other special purpose batteries, used in guided missiles and other defense projects.

The Raleigh Laboratory employs 125 people. Of these, 27 are engineers and designers with broad ex-

(Continued on page 397)

no need to over-tax your production facilities

Complex assemblies such as this Y-4 bombsight used in B-47 Stratojets are taken in stride at General Mills. This precision instrument has 3,433 parts, nearly 2,000 of them in this head-end assembly alone.

get precision production help in volume and on time

The critical shortage of competent technical men needn't handicap your operation. Right now our creative engineers and precision manufacturing facilities are at your service for subassemblies or complete units of:

- **precision electro-mechanical systems**
- **fine-pitch, instrument-type gear assemblies**
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We can save you time, cut costs, eliminate scores of irksome production problems. Naturally you have the service of our full laboratory and environmental testing facilities.

Send for this Fact-Packed New Booklet — It describes and pictures our facilities, shows our products, names our customers. Write Mechanical Division, Dept. PE8, 1620 Central Ave., Minneapolis 13, Minn.

MECHANICAL DIVISION OF General Mills

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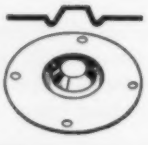
IN THIN SECTIONS AND SHAPES . . .

CAN IMPROVE PRODUCT PERFORMANCE AND CUT REPLACEMENT COSTS

TEFLON is not a substitute for rubber, leather, or other sealing materials . . . TEFLON is in a class by itself, and there is no substitute for quality and performance.

TEFLON has a combination of chemical, electrical and mechanical properties unmatched by any other single material. Such characteristics as chemical inertness, resistance to corrosion, high heat resistance, toughness, high dielectric strength, low co-efficient of friction offer you design and product-improvement opportunities never before possible.



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"DEPT. PE"

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IMPORTANT!

As an added service to YOU, Sparta can now fill your requirements for

TEFLON
FLEXIBLE THIN WALL
& SPAGHETTI TUBING

SPARTA MANUFACTURING CO.
DOVER, OHIO
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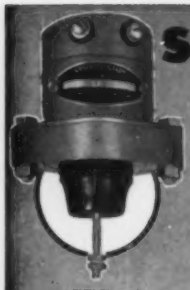

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FOR D. C. ONLY

Synchro-Start MODEL SS-B SOLENOID in its enclosed casing has the extra protection from any seepages of foreign substances by the addition of a specially constructed boot. This boot is made of a synthetic rubber that is oil and grease resistant.

Also available with the protecting boot is a SYNCHRO-START Solenoid with the standard aircraft A N Connector (Model SS-AB).

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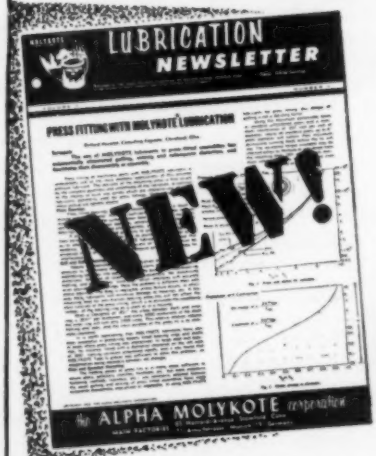

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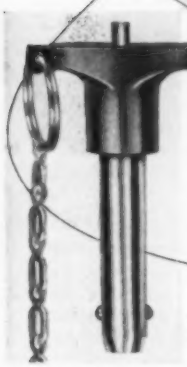

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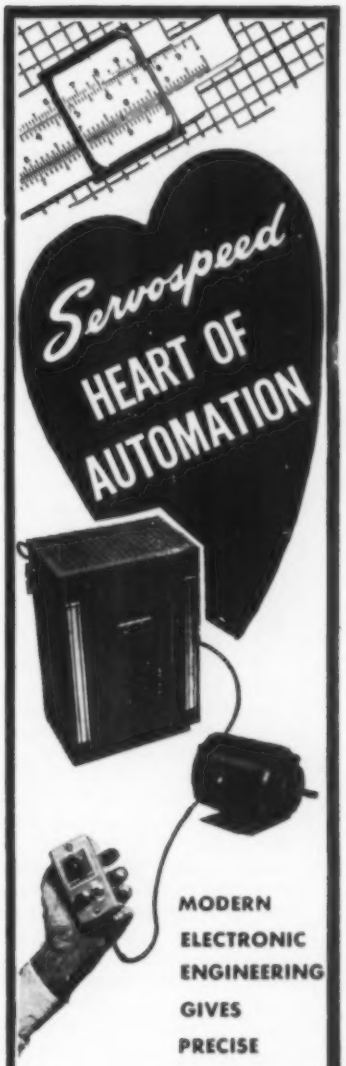
Lincoln Electric Announces Expansion

The Lincoln Electric Company of Cleveland, Ohio, has announced an 8 million dollar expansion to its plant capacity for manufacturing arc welding machines and electrodes. Work is underway to complete 2 million dollars of this expansion by the end of the year. Engineering on the remainder of the work is starting. The entire project is planned for completion within the next three years.

The expansion will provide 60 per cent more manufacturing capacity in the Company's five-year old, 20 acre Cleveland plant. Extensions will be made to the building for new facilities and new equipment will be installed in existing production areas.

The Company is also building new plants in France and Australia to replace the present plants in those countries and is also adding to its Canadian plant.

President William Irrgang announced the expansion with the statement that the welding industry still has a large untapped potential market in several different areas. He referred to the machinery manufacturing industries rapidly adopting the use of weldments, and the structural field where welding is rapidly replacing other fabricating methods.



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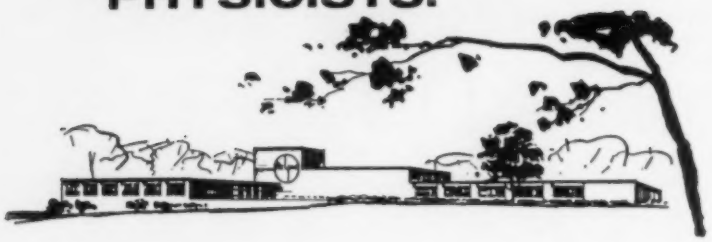

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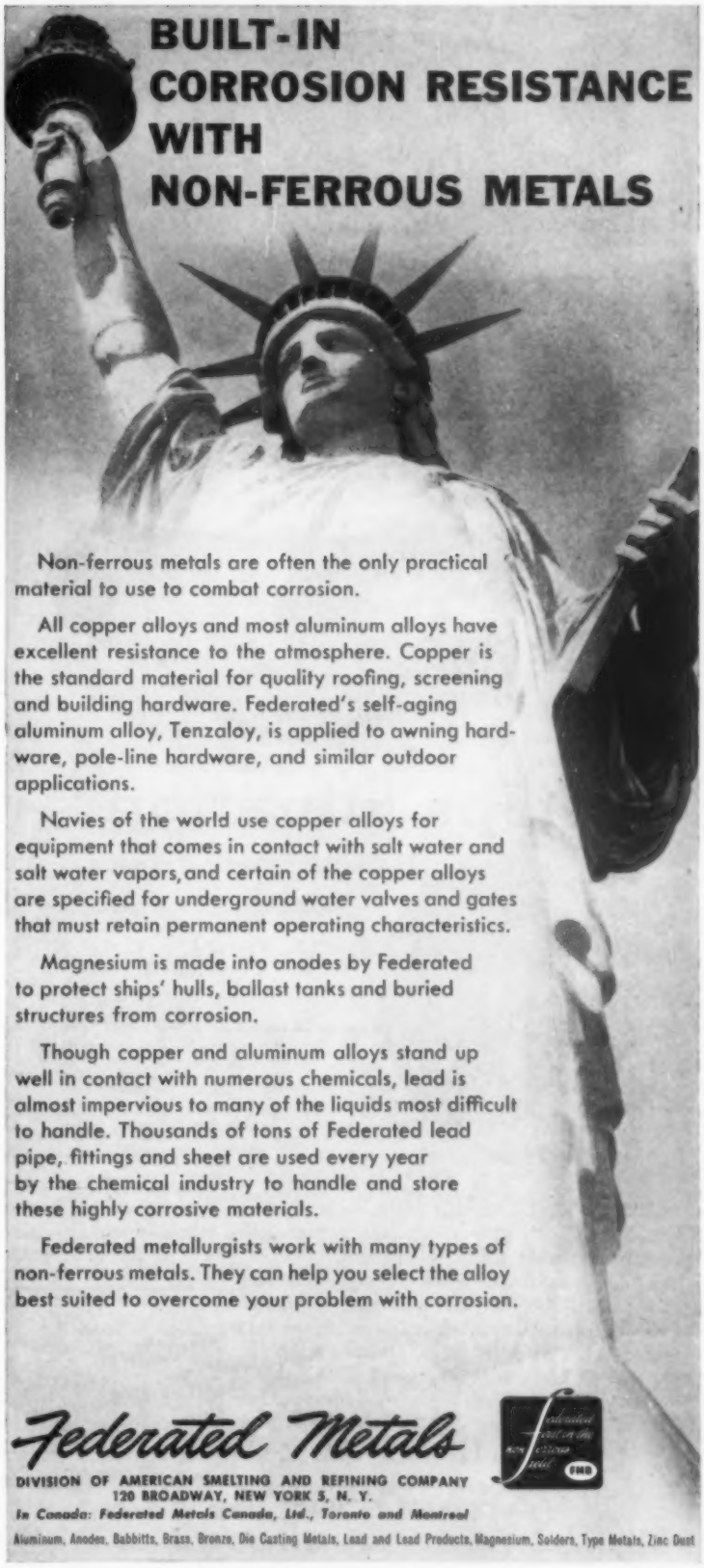
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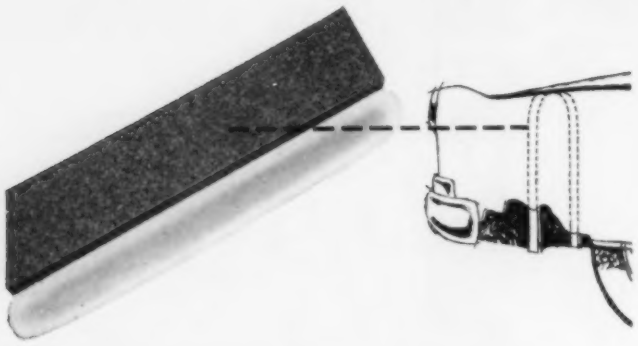

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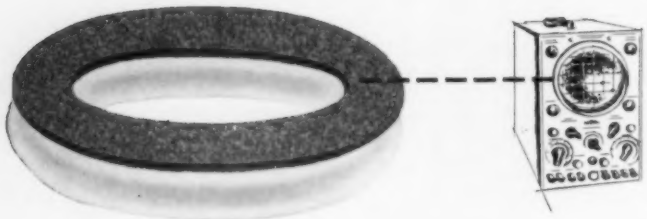

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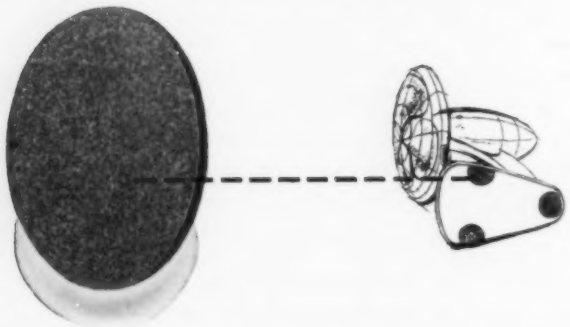

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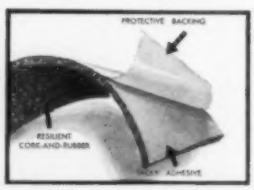

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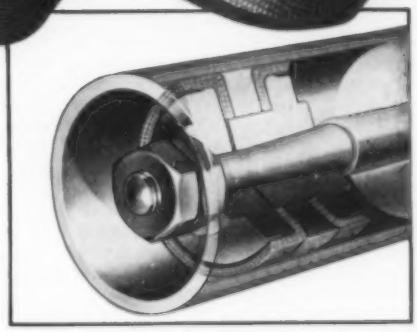

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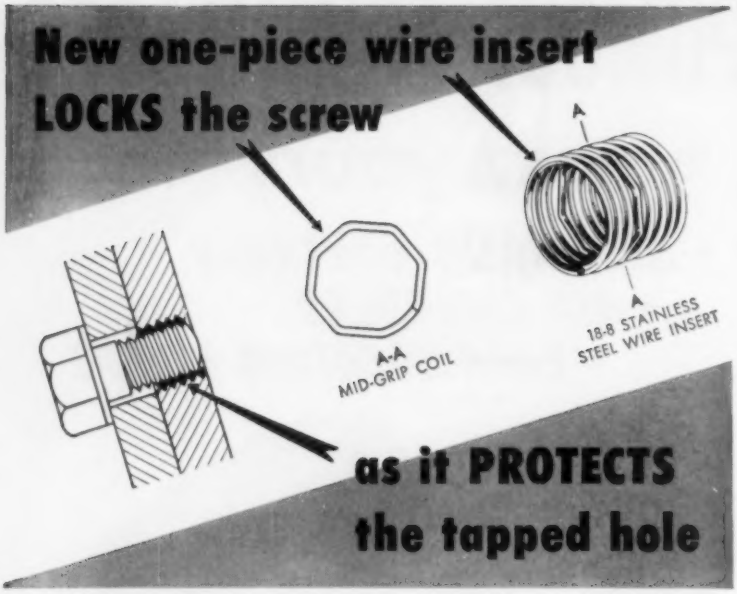

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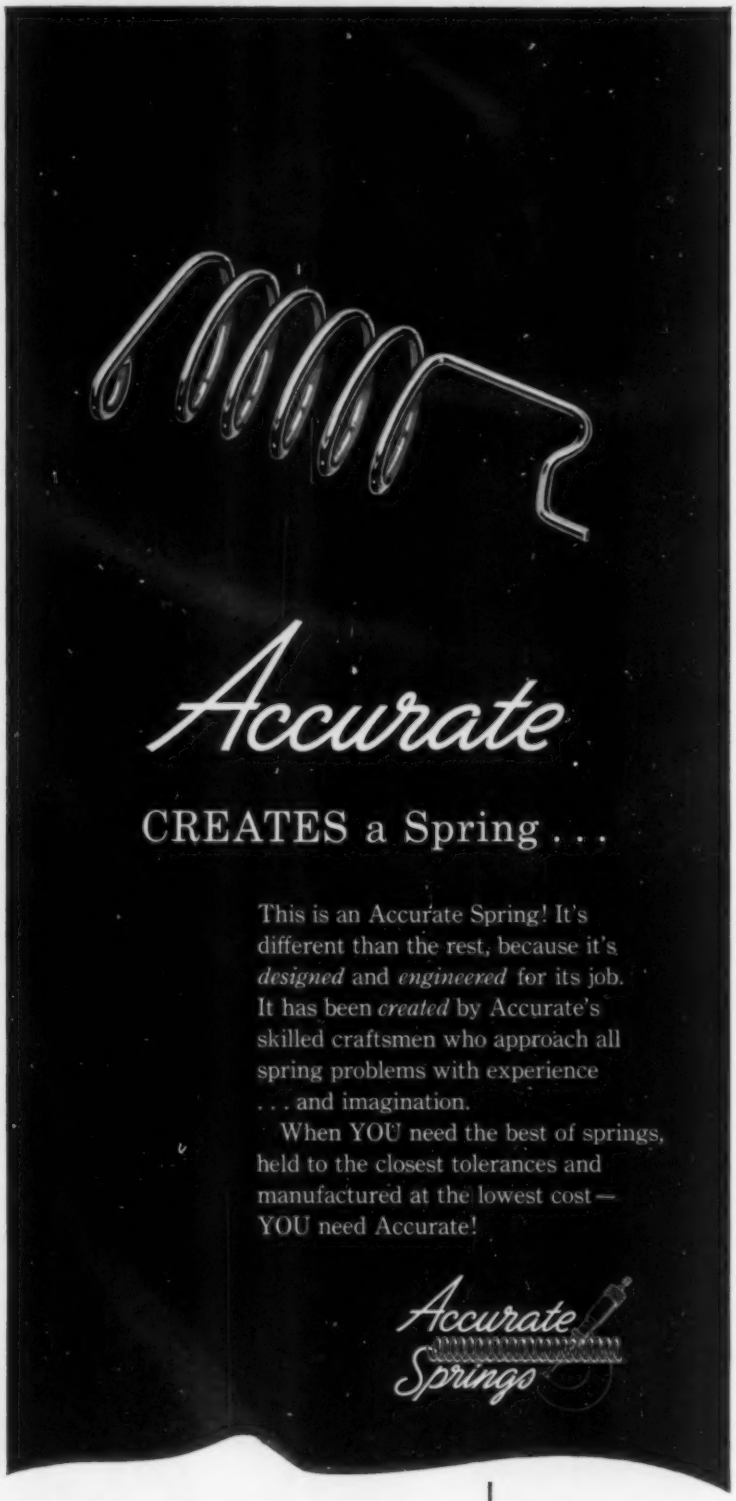
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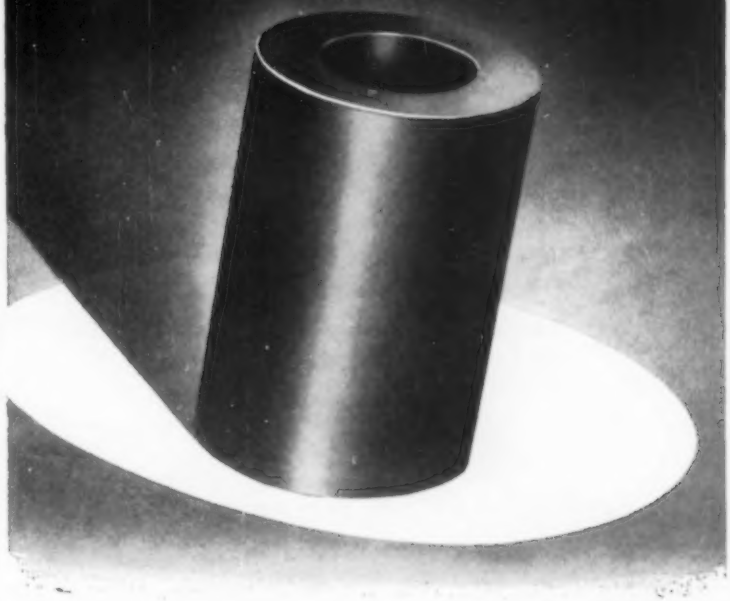

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Phoson solves "hidden joint"

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Everyday . . . this leading *manufacturer PHOSON brazes over 5400 hard to see and reach copper joints. Even though hidden deep down in air conditioning unit assemblies, "leaker" rejections are less than ½ of 1%!

High capillary attraction at low temperature, without flux, make United's Phoson 6 perfect for such tough "in close" brazing jobs.

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For all types of hand fed or automatic copper brazing, Phoson 6 has every desirable characteristic you want . . . high capillary attraction, lowest possible brazing temperature, greatest resistance to vibration and lowest possible cost.

*Name on request

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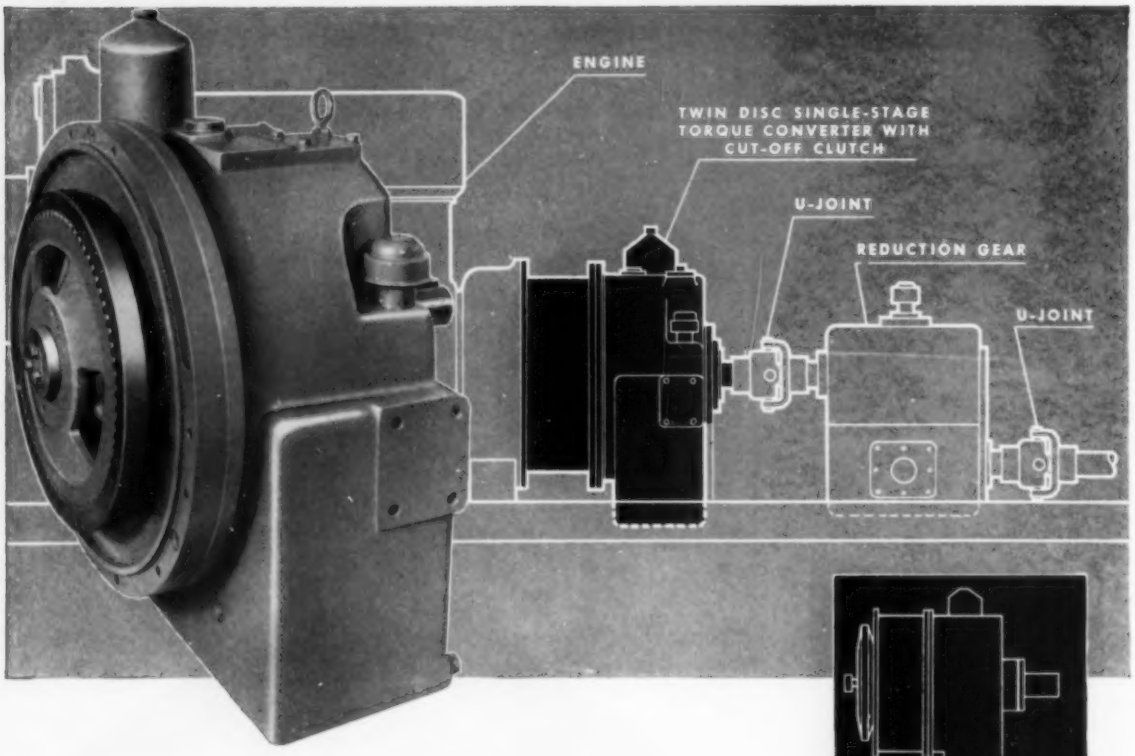

Design this new *SINGLE-STAGE* Torque Converter into your machine

If your problem is matching single-stage torque converter characteristics to powered equipment, here's the ideal solution: Design the new Twin Disc Single-Stage Torque Converter into your machine!

This new single-stage unit is designed and built with all the latest engineering advances—yet retains the basic features that have made Twin Disc Torque Converters the world's most widely used for industrial applications. It's now available in the 1500 Series . . . in a variety of model arrangements . . . in a number of torque capacities . . . from 30 to 207 hp input . . . to meet the widest variety of requirements. Its unique but field-proven design eliminates the need for a free-wheeling device . . . eliminates one more possible trouble spot. Its heavy-duty construction features ample bearing surface throughout . . . for long life and minimum maintenance . . . even where the going is roughest.

Find out more about this new single-stage torque converter . . . how it can help bring out maximum performance in *your* powered products. Write Twin Disc Clutch Company, Hydraulic Division, Rockford, Illinois. Request Bulletin 508.

A *complete line* of torque converters, both single-stage and three-stage, for internal combustion engines from 30 to 1000 hp.

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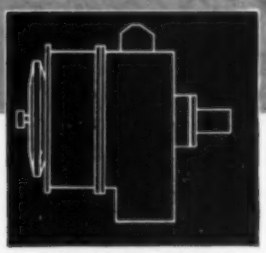
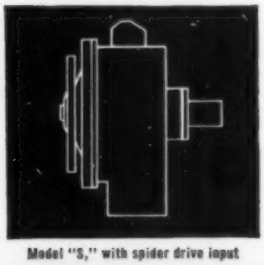
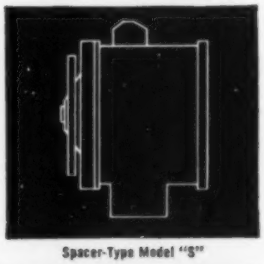
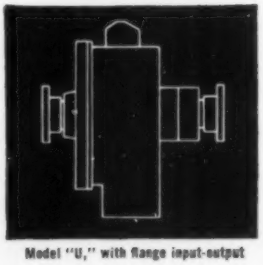
TWIN DISC
Torque Converters


Model "C," with clutch input


Model "S," with spider drive input


Spacer-Type Model "S"


Model "U," with flange input-output

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For your copy of any new catalog or bulletin, circle key numbers in the space indicated. Bulletins are described on pages 340-357.

To get more data about new Components, Materials and Parts fully described on pages 226-339, just circle the appropriate key number.

To get more information about advertised products, circle the page number of the advertisement in which you are interested. If more than one advertisement is located on a single page, letters preceding number identify each advertisement. Key: T–Top; B–Bottom; R–Right; L–Left; TL–Top left; BL–Bottom left; TR–Top right; BR–Bottom right.

For specialized data . . . prices, sizes available, nearest source of supply, etc. . . . do not circle key number but indicate your needs in the space allotted at the bottom of the card. Use this space, too, if information about a specific product among several mentioned in an advertisement is desired.

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1—Glass Bead Filter
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4—Multiple-Circuit Hydraulic Power
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18—Appliance Relay
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34—Porous Glass Epoxy Tubing
35—Power Relay
36—Programmable Power Packs
37—Liquid Compression Springs
38—Precision Ground Glass Balls
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42—Solenoid Control Valve
43—Nut With Self-Locking Collar
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52—Edgewise Panel Meter
53—Coupler For Fluid Lines
54—Cooling and Lubricating System
55—Film-Type Heating Element
56—Primer for Galvanized Metals
57—Lever Switch With Safety Lock
58—Pilot-Operated Control Valve
59—Small-Size Hydraulic Power Unit
60—Down-Time Recorder
61—Variable Speed Drives
62—Actuator Motor
63—Tachometer for Rotating Machinery

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64—Nylon Pipe
65—Toggle Valve
66—Heavy Duty Vacuum Switch
67—Explosive Valve
68—Tension Compression Liquid Spring
69—Boots for Toggle Switch
70—Miniature Lugs and Rivets
71—Rotary Latch
72—Oil Cooled Friction Material
73—Disc-Type Magnetic Brake
74—Rolled Nylon Washer
75—Fhp Induction Motor
76—Subminiature Tantalum Capacitors
77—Thermostat Controls Circuits
78—Constant Speed D-c Motor
79—Centrifugal Blowers
80—Piping Compensator
81—Fhp Motor Speed Control
82—Potentiometer Transmits Signal
83—Analog-to-Digital Converter
84—Sealed Switches, Relays
85—Automatic Control System
86—Traction Type Fluid Drive
87—Subminiature Relay
88—Sequencing Air Valves
89—Air-Operated Toggle Clamp
90—Self-Aligning Spherical Bearings
91—Right-Angle Gear Reducers
92—Rotary Switch
93—Electric Clutches and Brakes
94—Ribbon Cable Assemblies
95—Hydraulic Control Valves
96—Epoxy Glass For Printed Wiring
97—Right Angle Gearmotors
98—Data Tables
99—Miniature Portable Controller

NEW BULLETINS . . . listed below are described

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100—Die Casting Standards
101—Connectors
102—Pumping
103—Variable Speed Drive
104—Speed Reducer
105—Flow and Level Sensing
106—Relays
107—Beryllium Copper
108—Plastic Laminates
109—Variable Pulleys
110—Power Take-offs
111—Subminiature Switches
112—Miniature Universal Joint
113—Laminated Metals
114—Power Transmission Equipment
115—Stainless Steel Castings
116—Indexing Tables
117—Sprockets
118—Relief Valves
119—Explosion-proof Motors
120—Leather Packings
121—Tolerances for Printed Circuits
122—Decimal Equivalents
123—Motors and Generators
124—Canned Motor Pump
125—Magnetic Power Transmission
126—PVC Pipe and Fittings
127—Heating Units
128—Trip Controls
129—Hydraulic Pump Motors
130—Leather Packings
131—U and V-Packings
132—Check Valves
133—Limit Switches

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NEW PRODUCTS . . .

NEW BULLETINS . . .

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124—Visual Aids
135—Wire-Wound Resistors
136—Miniature Flexible Couplings
137—Chrome Treatment of Steel
138—Panel Fasteners
139—Rotary Switch
140—Shock and Vibration Mountings
141—Machine Tool Clutch
142—Vibration Isolation
143—Servo Motors and Generators
144—Electric Furnace Iron
145—Beryllium Copper Strip
146—Nickel Alloy Tubing
147—Hose Fittings
148—Blind Rivets
149—Perforated Metals
150—Back Pressure Control
151—Rotating Limit Switch
152—Variable Speed Drive
153—Nickel Alloy Tubing
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155—Air and Vacuum Pumps
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165—Shock and Vibration Mounts
166—Single-Phase Motors
167—Plastic Products
168—Valve Stem Packing
169—Gearmotors
170—Automatic Clutches
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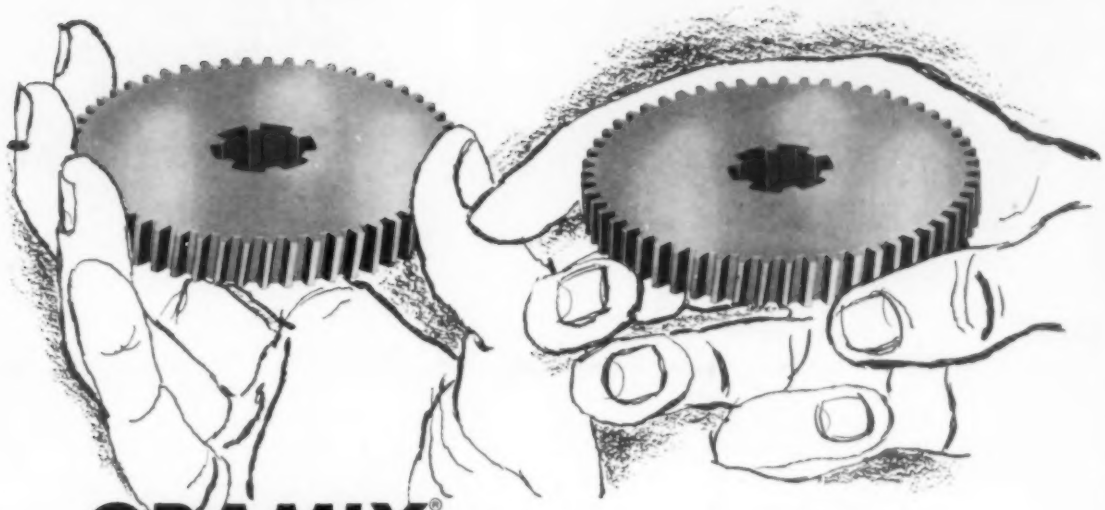
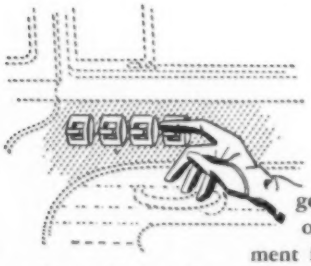
Requests for information made through *Product Engineering* Reader's Service will be forwarded to the manufacturer as quickly as we can process them. If you write directly to the manufacturer, please identify advertisement by issue and page number to facilitate reply.

which helical gear costs 80% less?



the GRAMIX® sintered metal helical gear performs better than a forged and hobbed aluminum part for just 1/5 the cost!



By replacing forged aluminum gears with sintered steel GRAMIX helical gears, a manufacturer of automotive equipment found that he could realize an 80% saving and get greater dependability. The gear is a component of an automatic window raising and lowering mechanism currently being used by four different automobile manufacturers. The helical teeth are formed in the compacting dies, and, after sintering, the GRAMIX gear is ready for assembly into the power window unit . . . there is no need for costly machining or time-consuming finishing operations like the hobbed aluminum gear used previously. In spite of the astonishing savings, these GRAMIX gears have proven to be even better than the former forged gear from a standpoint of toughness and wearability.

GRAMIX metallurgists can provide the exact alloy for your design specifications. GRAMIX parts may be oil-impregnated for self-lubrication. They seldom need machining, and will often outlast similar machined parts. Complex shapes can be produced to tolerances as close as .0005". Whatever your requirements may be, it will pay you to investigate GRAMIX.

Do you have our big detailed GRAMIX catalog? . . . write today for your copy.

114

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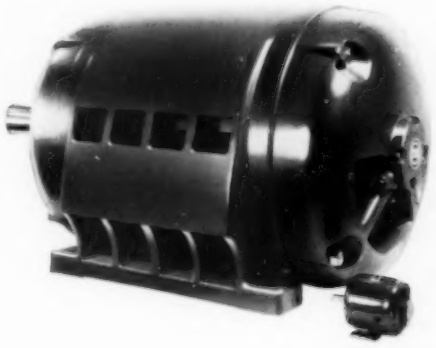
From 1/8 to 400 H. P.

See MASTER for a selection of motor drives that you can get nowhere else—for specialized power drives unequalled for flexibility, compactness and performance. See Master for the right horsepower, right shaft speed, right mounting features—to add salability to your products, efficiency to your plant equipment.

Master components are designed to combine in one compact unit to suit your needs exactly—all the way up to 400 H. P. Just ask us for information.



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Motor Types	Squirrel cage, slip ring, synchronous, repulsion-start induction, capacitor, direct current.
Construction	Open, enclosed, splash-proof, fan-cooled, explosion-proof, special purpose.
Speeds	Single-speed, multi-speed, and variable speed.
Installation	Horizontal or vertical, with or without flanges and other features.
Power Drive Features	Electric brakes (2 types)—5 types of gear reduction up to 432 to 1 ratio. Mechanical and electronic variable speed units—fluid drives—every type of mounting.

THE MASTER ELECTRIC COMPANY
Dayton 1, Ohio

MASTER ELECTRIC MOTORS